THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. I.—*On Zoöphytes*, No. III; by JAMES D. DANA.*

26. IN our preceding chapter on Zoöphytes we briefly noticed the characteristics of the Hydroidea, one of the two grand divisions of these animals. A digestive cavity, a mouth, and a circle of fleshy arms or tentacles around the mouth, were mentioned as the sum-total of many of these simple organisms. Fixed in general to some support, they eat, and grow, and bud out their young as plants their flowers and leaves. Thus they form the fine feathery fronds and moss-like tufts so common among these lower polyps, and whose branchlets are made up of minute flower animals in place of leaflets, exquisite in beauty and arrangement. They have delicate horny or membranous coralla when any at all, and take little part in the formation of reefs.

Order II. ACTINOIDEA.

The next order to which we now pass, comprises all the ordinary coral zoöphytes, the branching and foliate Madrepores, the massive Astræas and Meandrinas, the slender sea fan, and also the common Actinia. Among them are flowers of all hues and sizes. The Actiniæ may well be called the Asters, Carnations, and Anemonies† of the submarine garden; the Tubipores and Alcyonia form literally its pink beds; the Gorgoniæ and Melitæas are its flowering twigs; the Madrepores its plants and shrubbery; and Astræas often form domes amid the grove, a dozen feet or more

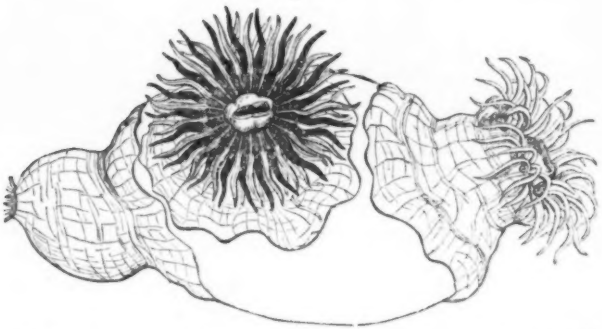
* Abstract of the Exploring Expedition Report on Zoophytes by the writer; continued from vol. ii of this Journal; see p. 64 for No. I, and p. 187 for No. II.

† Sea-Anemone is the common name.

in diameter, embellished with green or purple blossoms which stud the surface like gems; while other hemispheres of Meandrina appear as if enveloped in a network of flowering vines.

27. It is impossible in any figures or sketches to convey an idea of the combined effect, where the various species are growing together. The resemblance in form to flowers* may however be appreciated from a few figures. In the following an Actinia is represented in its different conditions, expanded and closed.

Fig. 12.



The similarity to an Aster is at once apparent, yet with this difference, that there is an opening at the center of the disk for taking food. The animal is fleshy throughout, and *expands* by taking in water and injecting itself and its tentacles, which being tubular organs, receive thus some degree of rigidity; it *contracts* by expelling the water again, drawing in thus the disk and rolling its border over the tentacles. The water passes out partly through the mouth, often in part through a puncture at the tips of the tentacles, and in some species through pores in the sides of the animal.† The next figures represent coral animals, resembling, as is seen, in every essential particular, the Actinia above, and differing internally in nothing except the power of secreting lime. Fig. 13 as well as 14 are both of the size of life, and the latter shows the average size of the polyps through the large genus Astræa. The former is a single animal from a large hemispherical group (a Mussa) consisting of fifty or sixty such polyps; and when alive, the whole forms a magnificent

* The gorgeous character of many Actinias may be appreciated from the colored figures on the first five plates of the atlas to accompany the volume on Zoophytes, by the very skilful pencil of Mr. J. Drayton, one of the artists of the Expedition. The animals of one or more species of nearly every genus of coral zoophytes are figured and colored on the other plates of the volume. The volume will not be ready for delivery, for some months.

† This last peculiarity has been supposed to belong only to tuberculate species; and Ehrenberg has founded on it, the genus Cribrina. But Dr. Wyman observed that these pores existed in the A. marginata of the Boston harbor, which has a perfectly smooth and semi-transparent skin.

cluster of animal flowers. The latter is from a small specimen of Astræa: were its disks and tentacles of some bright shades of color, and the small hemisphere enlarged to a diameter of twelve

Fig. 13.

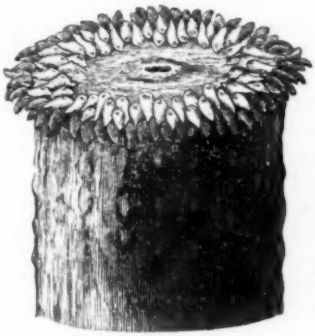
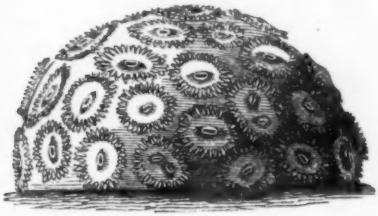


Fig. 14.



feet, it would then give some idea of the domes of the coral reef, to which we have made allusion above. Fig. 38 on a following page is another variety. Figures 15 and 16 represent a *Madre-*

Fig. 16.

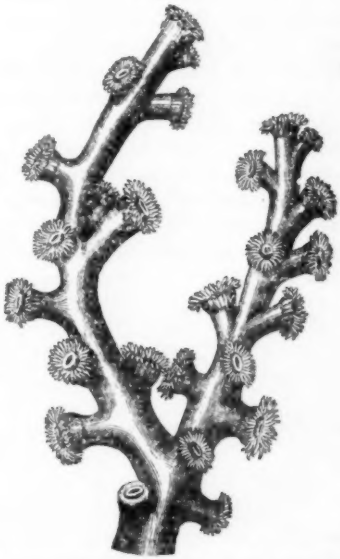
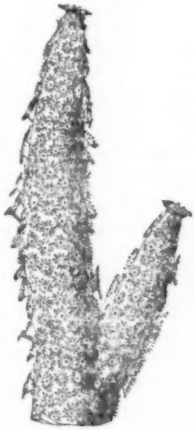


Fig. 15.



*pora* and a *Dendrophyllia*, of natural size; and they bear out the remark that a branch is literally a spike of flowers. Figure 17 also sustains our comparison of the Alcyonia to clumps of

Fig. 17.

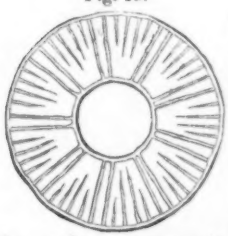
pinks, although but a single branch, and without the delicate tinting which characterizes these flower-animals. In the annexed figure (18,) a polyp of a *Tubipora* is represented enlarged. A large cluster, as it appears in the water in full expansion, is closely like a bunch of lilac blossoms, both in shade of color and in the size of the polyp flowers.

Fig. 18.

28. All these animals have the same general structure, and differ from the Hydroidea in the internal septa, possessed of genital functions, which divide the visceral cavity into radiate compartments, (§ 11.) They sometimes have a coriaceous or leathery exterior; and *instead of living in coral, the coral is contained in them.* In figure 13, the existence of coral is no more apparent externally, than in the fleshy Actinia. The tentacles are very various in number and size; they are sometimes long for prehension, and at others are nearly or quite rudimentary, being fitted only to aid in aeration.

29. In the interior of the Actinia, within the general visceral cavity, there is a cylindrical stomach which is attached to the under side of the disk, and is about two-thirds the length of the animal. The cavity around the stomach is divided by the fleshy septa alluded to; they unite this organ to the sides of the polyp and by their muscular action aid in its contraction. The compartments formed between them communicate each with a tentacle, (unless a part of the normal number of tentacles be obsolete.) Two large septa in many cases alternate with others which are narrower. This is shown in the annexed cut of an ideal transverse section in which the inner circle represents a section of the stomach, and the radiating lines, sections of the septa extending from the sides of the polyp.* The septa are continued below the stomach, and at bottom are prolonged inward so as to meet. The cavity of the stomach has a free communication with the visceral cavity, being closed below only by muscles under the control of the animal.

Fig. 19.



* The septa in this figure are much less numerous than in the Actiniæ, but are correct in representing the general arrangement.

The food, which consists of small crustacea and any thing that falls in their way, is acted upon by the gastric juices in the stomach, and the insoluble portions ejected by the mouth. The chyloid fluids formed by the digestive process then pass below into the visceral cavity, and are distributed throughout it to be absorbed and assimilated by the interior surface and through the pores or cavities connected with it. The water which is received on expansion has the same course, and contributes along with the exterior waters to aeration; and thus aeration and assimilation go on together without any special organs for these functions. Excrementitious matter is probably ejected along with this water.*

30. The septa have been stated to have genital functions, and this is their principal object. Part are ovarian and part spermatic. The spermatic are margined with an extremely delicate white cord-like or capillary organ, long and much convoluted, (lower part of figure 26*a*;) and the ovarian, (which appear in general to be the narrower of the septa,) bear clusters of ova at the margin, (fig. 20.)

Fig 20.

The spermatic nature of these white cords, was first suggested by Dicquemare,† and afterwards established by Wagner.‡ Their singular radiated spiculigerous structure was also made out by our acute microscopist, Prof. Bailey of West Point,§ and subsequently the actual forms of their spermatozoa, and of three distinct kinds of spiculiform organs were developed with great skill by Dr. Jeffries Wyman of Boston. The structure is illustrated by the following figures, which are all by Dr. Wyman excepting figure 21 from a camera lucida sketch by Dr. A. A. Gould of Boston. Figure 21 shows the ordinary appearance of a cord under pressure when highly magnified. Figure 22 is a section showing the spiculiform organs, and the filaments which extend on slight pressure. Figure 23 represents the spermatozoa;

Fig. 21.

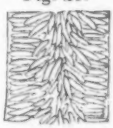


Fig. 22.

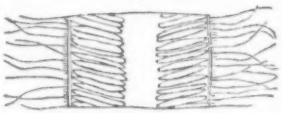


Fig. 23.

Fig. 24.

and figures 24, *a*, *b*, *c*, the three kinds of spiculæ with their filaments. The body of *b* is transparent; the filament is furnished

* Hence the mouth *is not* the only passage for the proper excrements, though it ejects the refuse indigestible matter from the stomach.

† Phil. Trans. Abridg., xiii, 639, 1775.

‡ Ann. des Sciences Nat., viii, (1837,) 282, from Wiegman's Archives, ii, 215, (1835.) See also Milne Edwards, Ann. des Sci. Nat., xiii, (1840,) 196.

§ Jour. of Boston Soc. Nat. Hist., iv, 252.

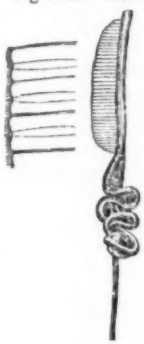
with short hairs, and has an obtuse extremity. The body of *c* appeared to be filled with granulous matter; the filament is enlarged, as in *b*, but is naked, and terminates in a very delicately attenuated extremity. These several forms were seen again and again from various individuals, and lately the researches have been repeated with the same results. The spermatozoa were observed to have motion.*

These cords had been considered biliary vessels by some writers and also as ovarian, before their spermatic character was ascertained. Their structure is finely figured by A. de Quatrefages† but without distinguishing the different kinds of spiculiform bodies or apparently appreciating their nature.

31. The clusters of ova lie in the visceral cavity, or its compartments, and sometimes are found in the tentacles as detected by Dalyell in frequent amputations of these organs, a fact easily understood since the compartments and tentacles communicate openly with one another. But according to the best authority, and observations in the Expedition by Mr. Couthouy, they leave the internal cavity through the stomach and mouth, sometimes as ova and sometimes as young animals. When first produced the polyps swim free, and have but few tentacles; they afterwards attach themselves, and the tentacles go on increasing in number correspondingly (or in some fixed relation) with the visceral lamellæ, until the adult number is attained.

32. In the Zoanthidæ, there is a pair of organs resembling *branchiæ*, (fig. 26*a*, upper part,) attached by a common duct to the edge of each visceral lamella just below the stomach. In fig. 26*b*, part of the margin is shown enlarged, with the vibratile cilia as they were seen in motion. The spermatic cord of the same lamella is represented in the lower part of figure 26*a*. These branchia-like organs were first observed by Lesueur, who called them *arcuated* organs. These figures are from dissections of a Palythoa by the writer. (See plate 30 of the work on Zoophytes.)

Figs. 26*b*. 26*a*.



These animals are as prolific, and repair an injury as easily, as the Hydroidea. Fragments of an Actinia are as sure to grow to a perfect animal, as chippings from a potato to a potato-plant. And they have been put in boiling water without serious injury.

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* These investigations were first published in the Report on Zoophytes by the writer. They were made on the *Actinia marginata* of Lesueur, which is common in the harbor of Boston. Dr. Wyman also detected great numbers of minute spiculæ (as here figured enlarged) in the coats of the stomach, general integuments of the body, and near the extremities of the tentacles.

Fig. 25.

† *Sur les Edwardsies*, Ann. des Sci. Nat., xviii, (1842,) 65.

33. The various species of Zoophytes having the above general characteristics, differ in the arrangement, number and character of the tentacles, and the size of the stomach as compared with the whole visceral cavity. In some Zoanthidæ the stomach is not over one-fifth the length of the internal cavity. Certain Actiniæ have part or all of the tentacles furnished with suctorial vesicles for clinging; and in others they are minutely divided or lobed and look like the most delicate embroidery. In a few species (Actinectæ) there is a vesicular float contained in a cavity in the base of the animal to fit it for a sea life, and through these species the zoophytes approach the Porpita among Acalephs. These are only family, generic, or trivial distinctions; but on another point, the Actinoidea are naturally divided into two Sub-orders.

34. A part of them have *uniformly eight tentacles, and these are fringed with minute papillæ, each papilla having a puncture at apex.* These are called the ALCYONARIA; they include the Alcyonia, the Xeniæ, (fig. 17,) Gorgoniæ, and Tubipores, fig. 18; the cells of their coralla are distinguished when calcareous by *being simple tubes without rays.*

In others, and here fall the Madrepores and most stony corals in addition to the Actiniæ, the *tentacles are without the papillæ of the Alcyonaria, and the number is six, twelve, or more.* These are the ACTINARIA. *The cells of their calcareous coralla are radiate*, the rays rarely becoming obsolete.*

Internally the Alcyonaria have eight visceral lamellæ. In one species of Tubipora examined by the writer, six of them were spermatic and two ovarian. Milne Edwards found that in a Veretillum six of the lamellæ were spermatic above and ovarian below, bearing analogy with a gynandrous plant.

35. The *Actinaria* are farther subdivided into the tribes Antipathacea, Madreporacea, Caryophyllacea, and Astræacea.

The *Antipathacea* have six tentacles; they form a horny axis but no calcareous coralla.

The *Madreporacea* have twelve tentacles; they form calcareous coralla having *the cells small, six to twelve rayed*, with the rays seldom obsolete.

The *Caryophyllacea* and *Astræacea* have more than twelve tentacles, and the *cells of their coralla have more than twelve rays.* Their distinctive characters will be pointed out in the sequel.

*Secretion of the Corallum.*

36. We have already insisted sufficiently on the fact that live coral is not a hive of polyps, as the words polypary and polypidom imply, but on the contrary is a result of animal secretion.†

* They are obsolete in some Favosites. Yet certain allied species (Favistellæ) in our American rocks have twelve distinct rays to the cells.

† This character of their secretions was first pointed out by Ehrenberg in his Memoir on the corals of the Red Sea, (Abhand. der König. Akad. der Wissensch. zu Berlin, 1832.)

The secretions producing it are of two kinds, either *basal and epidermic* or *internal*. The former are either *calcareous* or *horny*, *rarely siliceous;* and with the exception of the Antipathi, they are confined to the Alcyonaria. The latter are *calcareous*.

37. *Internal secretions.*—These take place through the inner tissues of the polyps; and as the internal cavity of these animals is radiated with compartments, it is natural that the cells of their coralla should be radiated likewise. Each compartment in fact corresponds to a calcareous lamella, these lamellæ being formed between two fleshy lamellæ. The existence of cells on the surface of a corallum is owing simply to the fact that the upper and central portions of the polyp do not secrete lime, while the sides and parts of the fleshy lamellæ do; the consequence is that there is a surface concavity in the corallum, into which the disk of the polyp falls on contraction. There can be no such thing as a disappearance of the polyp in the cell, for the coral as we have said is wholly within the exterior skin of the polyp; yet the tentacles and disk may disappear; and this they do also in the *fleshy* Actinia. Conceive of a fleshy Actinia secreting lime throughout the tissues of its sides, (excepting the exterior skin,) and between its fleshy lamellæ, and the reader will correctly comprehend the relation of coral to the animal. The calcareous secretions may thus form a solid structure penetrated by the animal tissues; and when separated from the animal there will be cellules where the animal tissues remained; and under a microscope a thin polished plate would show other animal fibres wholly enclosed in the coral. The animals represented in figures 12 and 13, differ in this single particular,—that in the latter this very process has taken place as described, and in the former it has not. There are many corals without surface-depressions or cells, and in these there is no semblance even of a retreat of the polyp.

The Madrepores, Astræas, Caryophyllias, and Cyathophylla are instances of this mode of coral secretion.

38. In the cells of most Caryophylliæ, Dendrophylliæ, &c., three smaller calcareous lamellæ (the middle one broadest) alternate with one larger lamella. This results from the arrangement of the *fleshy* lamellæ of the polyp, as shown in figure 19, and more correctly in the annexed figure, exhibiting the position of these lamellæ as seen through the skin of the Actinia examined by Dr. Wyman. There are two stouter lamellæ with *one broader* interval alternating with two thinner lamellæ and *three narrower* intervals, thus corresponding exactly with the calcareous lamellæ, the larger calcareous lamella belonging to the broader interval. This arrangement of the fleshy lamellæ may be seen in the external markings of many Actiniæ. This explains what has been considered a very singular structure in

Fig. 27

corals. On this account the number of lamellæ (and correspondingly of tentacles) is usually some multiple of *four*, when the whole number exceeds twenty-four; and it is generally also a multiple of *six*. Below this, the lamellæ if over six are commonly large and small alternately, or one alternates with two others that are alike; and the number is a multiple of *six*. These are therefore all parts of one system. The Alcyonaria appear to belong to a different system, since they have *eight* equal tentacles and lamellæ.

39. The importance of number and size as a specific distinction is therefore obvious. In the species of a single genus or family, there is a relation admitting of limited variations, between the diameter of the polyp and the number of its visceral lamellæ, and therefore of its calcareous lamellæ when coralligenous. As the number of tentacles and internal lamellæ of a polyp increase as it enlarges, so it is with the lamellæ of the corallum; but the adult number is fixed.

40. In the *Alcyonaria*, the internal secretions are in disseminated grains or spiculæ, and when a solid tube is formed, it proceeds from the aggregation of these grains. The difference in the microscopic structure of these spiculæ and the coral of the Actinaria has been stated in this Journal, i, ii Ser., 284. There are many species that are wholly fleshy, others in which the grains are few and the zoophyte is therefore still flexible; and others that are firm and solid from their numbers and union. In the Tubipora the tubes are thus solid except at tip where they are still flexible; and as they grow upward, the tube at the same rate stiffens above through the increasing calcareous secretions. In this Sub-order, the skin appears often to take part with the inner tissues in these secretions.

41. *Basal epidermic secretions.*—These secretions go on either alone or in connection with internal secretions, but always when together the two form separable layers. Thus the crust of a Gorgonia, which consists of a layer of fleshy polyps with internally secreted lime, peals off readily from the horny axis, which is the result of *basal secretions*. The polyps have their bases inward, and of course an axis should result from their united secretions. This axis is very similar in nature to the horn or nails of animals, which are alike epidermic, and to the fibrous *byssus* of certain molluscs. It is also calcareous at times as in the common red or noble coral of commerce; for this material forms the axis of a zoophyte, and is covered, when alive, with a layer or crust of brilliant polyps. This fact accounts for its being solid in texture without the cells of ordinary coral.

A concentric structure may sometimes be distinguished in these axes; and at times the centre (the first secretions of the younger or apical polyps of a branch) is open cellular. In some species the

whole axis is made up of spiculæ, or consists of a material resembling cork in texture.

42. In the Melitæas the polyps grow obliquely upward, and their bases are directed downward instead of inward. The foot secretions form a layer at base, of this cork-like material; upon this, the other secretions make a layer of lime; then a new budding takes place, and the new polyps begin another layer at base. Thus an alternation of the two kinds is produced, and the branches of the zoophyte are jointed.

43. With regard to the chemical constitution of calcareous corals, the results of Mr. Silliman's investigations for the Treatise on Zoophytes are already given in this Journal.* The occurrence in them of fluorine and phosphoric acid, was first detected by Mr. Silliman. The former was made to record the fact of its existence in coral during his investigations, by various etchings on glass, the specimens of which are of high interest.

44. The source of the ingredients of coral must be looked for in the food of the polyps, and in the ocean's waters which are constantly bringing new portions of these mineral materials over the coral reefs through the action of the waves and the great marine currents.† There is no foundation whatever, as far as my investigations among reefs go, for the hypothesis that carbonic acid springs occur in the vicinity of growing corals; and farther, there is convincing evidence to the contrary. Moreover, it matters not whether the lime in sea-water be in the condition of a sulphate or carbonate, since the elaborations of life may decompose and recompose according to the nature of the animal functions.

### *Reproduction by Buds.—The Compound Structure.*

45. We have been considering in the preceding pages on the Actinoidea, the characters of the *simple* polyp, its structure, reproduction by ova, and its coral secretions. The *compound* structure exhibited by most coral-zoophytes, is a result of the additional function of budding, and essentially in the same way as in the Hydroidea. By this simple means, all the various forms of zoophytes result.

Many of the various shapes which these zoophytes assume, are familiarly known. Madrepore shrubs and trees, and the sea-fan and other Gorgoniæ from the West and East Indies, are common in collections. The hemispheres of *brain-coral* (Meandrina), and also of *star-coral* (Astræa), are often met with. It is

* See this Journal, i, ii Series, 189; and also for some geological deductions therefrom, *ibid*, ii, 88.

† The occurrence of fluorine in sea-water was suggested by Mr. Silliman, as a result of his investigations; and it has since been proved by actual analysis by Mr. G. Wilson of Edinburgh. (See this Journal, ii, ii Series, 115.)

very generally supposed that these are by far the most frequent, if not the only shapes presented; but, on the contrary, the varieties are extremely numerous, as we have already intimated. Some species grow up in the form of large leaves rolled around one another like an open cabbage, and *cabbage-coral* would be no inapt designation for such species. Another foliated kind consists of leaves more crisped and of more delicate texture, irregularly clustered;—*lettuce-coral* would be a significant name. Each leaf has a surface covered with polyp-flowers, and was formed by the growth and secretion of these polyps. Clustered leaves of the acanthus and oak, are at once called to mind by other species; a sprouting asparagus-bed by others. The mushroom is here imitated in very many of its fantastic shapes, and other fungi, with mosses and lichens, add to the variety.

Vases of Madrepores are common about the reefs of the Pacific. They stand on a cylindrical base, which is enveloped in flowers when alive, and consist of a network of branches and branchlets, spreading gracefully from a centre, covered above with crowded sprigs of tinted polyps. The vases in the collections of the Expedition, at Washington, will bear out this description, although but the lifeless coral.

The domes of Astræas are of perfect symmetry, and often grow to a diameter of ten or twelve feet without a blemish. The ruder hillocks of Porites are sometimes twenty feet across. Besides these, we might describe columns, Hercules' clubs, and various strange shapes which are like nothing but themselves.

It is an enquiry of much interest, how these various forms proceed from the budding process.

46. Buds grow from some part of the parent, generally appearing first as a small protuberance upon its side, and afterwards perfecting into a complete young animal with its mouth and tentacles. The nature of the union between the young and parent has been explained in the preceding volume of this Journal, p. 190, § 13. Each of the compound zoophytes above alluded to, commenced from a single polyp and was thus formed; bud followed bud, and so the germ grew up into the coral tree or dome. Calculating the number of polyps that are united in a single Astræa dome, twelve feet in diameter,—each covering a square half inch,—we find it exceeding one hundred thousand; and in a Porites, of the same dimensions, in which the animals are under a line in breadth, the number exceeds five and a half millions; there are here, consequently, five and a half millions of mouths and stomachs to a single zoophyte, contributing together to the growth of the mass, by eating, and growing, and budding, and connected with one another by their lateral tissues and an imperfect cellular or lacunal communication. There is hence every variety, as to number, among compound zoophytes,

down to the simple polyp, which never buds at all, and has, for its corallum, a simple calicle;—it may be a tiny goblet, with a stellate cell, as in the Cyathina—a cylindrical cup, as in some Dendrophyllias—or a radiated disk, as in the Fungias and Cyclolites.

47. *Modes of Budding.*—Buds may be either *lateral* or *terminal;* that is, they may form from the sides of the parent, or from the disk or margin adjoining the disk. Lateral budding requires no farther explanation in this place. It is illustrated in figure 32, where the cells of young polyps are seen on the side of the parent stem.

*Disk budding* is peculiar in the steps of the process, and is illustrated in the following figures. Figure 28 represents the upper view of an Astræa polyp, resembling in every respect an Actinia; in figure 29, the same polyp disk is enlarged in one direction, and it contains *two* mouths instead of one, a new one having opened; the tentacles have multiplied with the increase of size. In figure 30, the single disk has begun to subdivide, and the circles of tentacles are

Fig. 28.

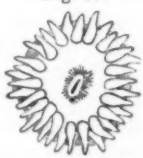
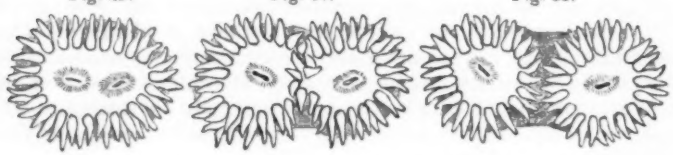


Fig. 29. Fig. 30. Fig. 31.

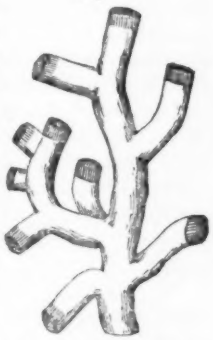


partially completed; in figure 31, we have the two polyps distinct. Thus a parent shares itself off to its young, and each goes on again with the same process of subdivision. They have at first a common visceral cavity; but by gradual growth they separate, excepting the usual intercommunication by pores or lacunes. This has been called an instance of fissiparous generation by Ehrenberg, who first described it, as it has much analogy with the mode of splitting in halves which is found among some infusoria. Yet it does not appear that there is ever a bisection of stomachs; the new mouth is exterior, apparently, to the stomach of the old polyp, and has its own stomach, though one visceral cavity contains the two. Milne Edwards has shown that the lateral budding of an Alcyonium commences in one of the visceral lamellæ, which we have described as the seat of reproduction. It seems altogether probable that this is a general fact, and that in these disk buds the point of gemmation is situated in a lamella just under the disk; consequently, the distinction between disk and lateral buds is rather in the position of the budding centre than in the nature of the process of gemmation.

48. Both lateral and terminal budding may go on continuously, in the same manner as buds proceed from the creeping shoot of a plant. A shoot or process continues elongating uninterruptedly, and at intervals gives out a young polyp; and in the same manner the margin of a growing folium may be constantly widening and giving out young polyps as it widens. This process is called by Ehrenberg, gemmation by *stolons*. Thus, while in some zoophytes the buds are produced only after intervals of time, the young approaching its adult size before budding, in other cases the process of budding and growth proceed together. In the one case the growth of the young absorbs the nutriment for the time being, and in the other, the nutriment goes at the same time both to promote growth and gemmation.

49. *Modes of Growth.*—1. The polyps of a compound group may be united at base only, and each may grow out as a separate branch, as in figure 32. 2. They may be attached also by their sides to one another. In the latter case, they may be united to one another to their very summits, or nearly so, as in Astræas (figure 14) and most massive coral-zoophytes, or they may coalesce only by their lower portions, and then the polyps will project when expanded. If projecting, the corallum will be covered with projecting calicles provided the upper part of the polyps secrete coral, as in most Madrepores: but if the secretions are only basal, there will be no calicles, and only shallow cells; this is the case in the Goniopores which have very projecting polyps but no calicles. Thus we explain many of the peculiarities of corals.

Fig. 32.



When each polyp forms a separate branch, as in figure 32, the zoophyte may be said to be *segregate* in growth; but when they are laterally coalesced as in the massive Astræas and the Madrepores, they may be described as *aggregate*. In the former case, the coralla may also be styled *caliculato-ramose*, as each calicle becomes a separate branch.

50. 2. Polyps differ also essentially in the *process of growth*. 1. Some polyps on reaching the adult size cease farther growth. 2. Others continue endlessly their growth above, and after a while commence the process of death below, so that life and death go on at equal pace. This we style an *acrogenous* mode of increase.* 3. Other species instead of growing upward, scarcely exceed their adult size in height, but grow laterally by

* From ακρον, *top*, and γενναω, *I increase*.

indefinite increase; and as this *prolate* growth is connected with budding, it often produces large foliate zoophytes.

51. The process of consentaneous growth and death is one of the most important in the history of zoophytes, for upon it depend the size they attain and their great geological interest. An example of it is illustrated in figure 32, representing a Carophyllia, the whole of which is lifeless coral excepting the polyp tipping each branch. The bud after development continues elongating its branch, and when but a line long, it dies at base, and so the polyp continues dying as it grows above. It is evident that such a process has no limits; and a little polyp may give origin by growth and budding to a large branched zoophyte.

An Astræa dome is an example of a different kind. Though twelve feet in diameter, it is alive only for half or three fourths of an inch from the surface: the living portion if separated, would form a thin hollow hemisphere or shell of polyps. The polyps growing outward desert the old coral below; or more correctly, the circulation ceases below as the increase goes on above, and consequently, the tissues dry up in the old corallum.

A branching Madrepora on the same principle is dead along the centre of a branch: and after attaining a certain height (differing for different species) it begins to die at base. A Goniopore may form a column several feet in height, and still be alive for only an inch or two at top. The addition of an inch at apex is death to an inch below. The length of the living portion is properly a fixed characteristic of a species in this and other genera.

52. In some Cyathophyllidæ this process of death goes on interruptedly, as explained by Ehrenberg. The tissues of the polyp disappear at intervals from the sides of the corallum, or become dead, leaving a row of unoccupied cellules; then the animal goes on to increase from its contracted size, without refilling the cellules; the corallum consequently becomes covered with encircling ridges, or appears as if formed of a series of inverted cones. In some cases, as in those species referred to the genus Strombodes, the living portion becomes retracted at intervals to the very centre, all the rest dying, and afterwards the animal grows again and spreads to its original diameter; and thus it forms actually one low inverted cone upon another. This peculiarity (probably an occasional result of the exhaustion which often follows reproduction) cannot properly be considered a generic distinction. In the Cyathophylla there are all varieties, from the very roughly wrinkled species to those which are smooth. There are also corals identical in structure with the Strombodes, which present nothing of it; and the same specimen is cone-in-cone on one part and solid or nearly so on others. The facts stated in the preceding volume, page 201, respecting the Hydroidea are in close analogy with the foregoing.

53. This retraction also takes place intermittedly at the base of the polyps in some species, giving rise to a transverse arrangement of septa, more or less regular, as shown in some Cyathophyllidæ, the Favosites and Pocilloporæ.

54. 3. Another peculiarity in the mode of growth is deserving of a few words. I refer to the ready *coalescence of branches.* Some foliaceous Madrepores are made up of coalesced branchlets, none of which are free excepting those at apex; and in others the whole is a network of united branchlets. Simple contact leads to this growing together. It is a union of the animals, but is followed by calcareous secretions which make the union solid. In the same manner, in the Strombodes above mentioned, the separate cones, (or polyps more properly,) become united as they enlarge to their adult size. A fragment of live coral will grow to another of the same kind if placed in contact with it; or if fixed upon a piece of coral rock will finally become attached to the rock and grow on as before.

*Connection of Budding and Growth.*

55. Some of the points in the structure and forms of corals have been explained in the preceding pages; a farther consideration of the same principles and others closely connected, will explain to us why the tree of stone spreads wide its branches, and how the leafy clusters, domes, and columns are formed.

We may remark separately upon the instances of lateral or *inferior* budding, and terminal or *superior.*

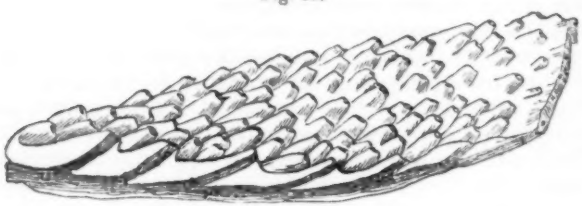
56. A. *Inferior Budding.*—1. If a *non-acrogenous* polyp buds laterally at base, by a single creeping stolon, it will form a linear zoophyte; but if the basal buds are given out in different directions instead of a single line, the zoophyte will spread out in a broad plate, or else a net-work, according as the polyps coalesce laterally or not. The Xenidæ illustrate all these varieties; and they pass into one another by gradual shades. Should the polyps grow together by their sides to their very summit, the thickness of the zoophyte will be equal to the height of the polyps; otherwise, there will be less thickness and the polyps will stand prominent when expanded. Both of these conditions are illustrated among the Zoanthidæ, and the gradations are so imperceptible that we see no propriety in retaining in this family this distinction as generic, though so adopted by former writers.*

The following figure of a Gemmipora illustrates the formation of plates by lateral budding, without acrogenous growth. The fact that the budding is lateral is shown by the internal di-

* The genus Palythoa should include therefore the Mammilifera of Lesueur; see Report on Zoophytes, p. 423.

rection of the cells in the front broken margin. The growth at the outer margin is of the stoloniferous kind, or takes place by

Fig. 33.

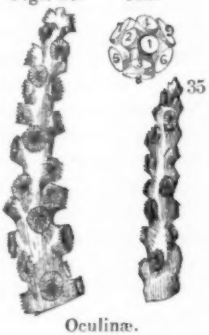


Gemmipora.

gradual extension and gemmation. Such forms are termed *explanate* or foliaceous.

57. A very different form results when budding takes place alternately from different sides of polyps growing a little obliquely. Thus in the annexed figures of Oculinæ, the apical polyp gives out a bud, which for a while is the summit polyp, and this bud another in the same manner, and that another, and so on, and in such an alternating, or properly *spiral* order, (figure 35*a*,) that a cylindrical branch is the consequence. This mode of branching may be called *cumulato-ramose*.*

Figs. 34. 35*a*.



Oculinæ.

This mode of development may also be considered as closely allied to that of the stolon, since growth and budding is continuous. Indeed there is no important distinction of the stolon, excepting the one alluded to in § 48.

58. 2. In the above instances the polyps have been supposed not to have acrogenous growth, or to possess it only in a very limited degree. When they are *acrogenous*, the results are various according to the mode of budding. If each polyp as it grows goes on to bud, and all bud thus equally and indefinitely, only globular or hemispherical forms can result. This is exemplified among the Porites: yet owing to slight irregularities or more rapid development in one part than another, the forms are usually irregularly glomerate rather than symmetrically globular. When the polyps are not connate by their sides, (that is are *segregate* in growth,) the same will still be the result, as shown in the Columnariæ, Tubiporæ, and Caryophylliæ.†

* The Oculinæ are somewhat acrogenous, and thus the semidiameter of the branches below becomes much greater than the height of a polyp.

† The Cladocoræ of Ehrenberg.

59. But if instead of budding indefinitely, the older polyps after a while lose the power, the zoophyte may commence as a small hemisphere, but will soon lengthen upward without increasing in width; the outer and older effete polyps ceasing to bud, begin the sides of a growing column. Budding will thus be confined to a summit cluster, of some specific size, (according to the species,) and the older polyps will leave the cluster at the same rate as others are produced. The branching Porites, Sideroporæ, and Pocilloporæ grow in this way through a *budding cluster* which constitutes the apex of each branch. Such branches have an obtuse extremity, excepting in the Seriatoporæ and some Gorgoniæ where the budding cluster is small.

60. Again, if the budding by which a branch is formed is confined to a single central polyp, which is acrogenous, then the branch will terminate in this *parent-polyp*, and the new buds will appear in succession around it, as it elongates. This terminal polyp is actually the parent of all the lateral polyps of the branchlet. This mode of growth characterizes the Madrepores and Dendrophylliæ, and any common species of Madrepore will illustrate it. Figures 15 and 16 are examples. The error of placing the Oculinæ with the Dendrophylliæ in one genus, as proposed by Ehrenberg, is thus obvious.

61. When the buds form seriately only on two sides of a branch we may have a two-edged form, as in the Pterogorgia anceps. And if they spread laterally, as well as face in two directions, they give rise to vertical plates, as in some Milleporæ.

62. If the buds are unsymmetrical, or form more rapidly on one side of a cylindrical branch than another, the branches grow more or less horizontally; and thus the vase Madrepores are produced.

63. *Modes of branching as connected with lateral budding.*—We have already alluded to the *caliculato-ramose* forms of zoophytes. There are other modes of branching which should be distinguished.

64. *Patrio-ramose.*—In the Madrepores, one of the non-budding lateral polyps, after the branch is sufficiently lengthened beyond it, begins to bud, and a new branchlet thus commences from this as its *parent-polyp*. The same is the case in the Dendrophyllias, and it is the universal mode in these genera. We may designate such zoophytes by the term *patrio-ramose*.

65. *Cumulato-ramose.*—In the Gorgonias, in much the same manner, a budding cluster (of one or more polyps) begins on the side of a branch, at some specific interval below the apex, and this, by growing and budding, produces a branch. The pinnules of the *Gorgonia setosa* form at regular intervals in this manner, and each commences four to six inches from the summit. At much greater intervals, one of the pinnules below begins to bud

near its base and give rise to branchlets, thus commencing to become itself a branch.

66. *Furcato-ramose.*—In most species which grow from a *budding cluster*, the multiplication of buds in this cluster generally widens it; and the consequence is that the cluster tends to exceed its normal limits in breadth. But soon the central polyps lose the budding power, and the branch commences to fork or subdivide into two branches. This mode of branching (*furcato-ramose*) characterizes the Porites, Sideroporæ, Pocilloporæ and other species.

67. If the polyps of a parent cluster rapidly elongate as in the Gorgoniæ the cluster does not widen, and such species cannot branch by furcation.

68. The position of branches as well as their size is determined by the principles adduced. In Madrepores the angle which the polyps make with the axis of the stem is the angle with which the new branch begins, and this angle varies little therefore in the same species. The length or size of the polyps, and the breadth of a budding cluster, limits the diameters of branches.

69. In the horizontally growing Madrepores, the new branchlets form on the outer or lower side of the branches, and afterwards become successively nearly or quite vertical. This mode of budding retains the zoophyte in a horizontal position.

The warty prominences on a Pocillopora arise from the fact that certain small clusters of polyps of two or three in each, and regularly distributed, continue to bud for a while among those which from age are just leaving the terminal clusters.

70. B. *Superior or Terminal Budding.* In lateral budding, the prolate growth of polyps takes place by the extension of their inferior portions; while in *terminal* budding it proceeds from the *extension of the summits.* The following figure of an Echinopora shows well this peculiarity, and it is still better understood on comparing it with the Gemmipora, figure 33.

Fig. 36.

Echinopora.

The margin grows by extension of the *upper* parts of the polyps, instead of the lower, and it is connected with terminal budding. The cells therefore are not united below to one another as in the Gemmipora. The new bud opens in the extending margin a

short distance from the edge, and there the polyp is developed; while in the Gemmipora the polyp cell opens at the very edge itself, and is continuous through the lower extremity of its visceral cavity with that of preceding polyps.

71. The Echinopora referred to is an example of *prolate* growth without *acrogenous*. In the Astræas, both modes are combined. The margin of an *Astræa argus* grows essentially like the Echinopora. But buds also multiply over the growing surface, as illustrated in the annexed figure. The growth, enlarging the surface, tends to enlarge the polyps and widen (in this species) the intervals between the disks. But this widening has its limits, determined by the normal size of the polyps, and when these limits begin to be exceeded, a new polyp buds out in the interval. An example of this is shown near the middle of the annexed figure. This process is constantly going on, and by means of it the symmetry of form which belongs to these hemispherical corals, is retained.

Fig. 37.

Astræa argus.

72. This prolate growth of the summits, instead of being confined to the parts exterior to the disks, belongs in many species to the disks themselves; and the consequence is that there is a tendency in these disks (and not in the intervals between them) to exceed their normal size. The result, namely, the opening of a new polyp, has already been described in § 47; and it takes place with the greatest regularity over the hemispherical Astræas.

73. In figures 28 to 31 we have illustrated the formation of a new polyp, and its subsequent separation from the parent. Suppose that instead of separating as soon as formed, the disk in figure 29 should continue widening, till another and another mouth opened before the subdivision (illustrated in the figures,) should commence. This is no hypothetical case, for the Meandrinas are all examples of it and in this simple particular alone, they differ from the common Astræas. There are some Astræas in which two or three mouths, or even four, occasionally open in a single widening disk, and it is difficult to say whether they should be arranged with the Meandrinas or not. There are Meandrinas in which the disk is prolonged indefinitely or subdivides only at long intervals. However great, therefore, the dissimilarity in the coralla of a Meandrina and an Astræa, their actual relations are extremely close. In some instances there are simple and meandrine species in the same genus (Mussa), for the reason that no line of division can be laid down.

74. As an Echinopora is related to the *Astræa argus*, so the foliaceous Merulinæ are related to the Meandrinæ and those Astræas that increase by *disk* buds. They are foliaceous Meandrinæ excepting a few species which are branching. The Monticulariæ differ from the Meandrinæ only in this; that the ridges of the latter are reduced in the former to isolated prominences, by a cross coalescence of the disk lines. The disk, instead of being prolonged, in a single line, is widened in two or three, and thus, this effect is produced. We have then a gradual passage from the Monticularia with a compound reticulate disk to the Astræa with a simple circular disk, and the differences depend upon the prolating disk subdividing or not, or its prolating in more lines than one. There are some branching Merulinas so closely approaching the Monticulariæ, that it is difficult to decide upon the genus to which they should be referred.

75. If the disk should widen in every direction, instead of in particular lines, still another variety would result not yet mentioned. The *Fungidæ* are instances of this. The simple species (Fungiæ) are polyps without margins to the disks; and the compound species (e. g. Polyphylliæ, Herpetolithi, Pavoniæ, Astræa siderea of Lamarck, &c.) have no intervals between the stars or disks. Like the lamellæ at the bottom of a trench in a Meandrina, the lamellæ of the stars pass *uninterruptedly* from one centre (oririme) to another, and this is their characteristic. Yet there are species with concave cells, because the intervals between two polyp-mouths may be prominent, and not because the disks are not confluent.

If the facts here stated appear to throw some difficulty in the way of distinguishing the genera and species of zoophytes by their coralla, we may say that no fault can be attributed to the author, for if any where, it pertains to the zoophytes themselves. In this matter we take them as our teachers. A proper study of recent zoophytes, we feel assured, will set aside to a great extent the apparent difficulties. In another place the various characteristics will be further dwelt upon.

Fig. 38.

76. *Modes of Branching.*—The annexed figure (of a Caulastræa) illustrates a common mode of branching among the ramose species. It is a result of the mode of disk budding already described (§ 47.) On one branch two polyp-mouths already ex-

ist in the enlarged disk; and at the extremity of the other, furcation has commenced. The subdivision is a consequence of the growth and budding; and as it takes place at nearly uniform *intervals*, and depends on the fact that the polyps *have normal limits of size*, the resulting zoophytes are generally very regularly hemispherical in form; moreover the branches in all individuals of the same species are very nearly *alike in size and in the intervals which separate them.* These characters therefore afford important specific distinctions.

77. Other species branch by a succession of buds, nearly as in the Oculinæ. This is the case with the Merulinæ, and may be seen in the branch-like processes over foliaceous species, as well as in the ramose species.

78. From the facts which have been presented, it appears that the distinction of *superior* and *inferior* gemmation and growth is of high importance in the classification of Actinoid Zoophytes. We observe farther that the species which bud just exterior to the disks, and those that subdivide the disks, should be arranged together. Very marked characters separate the Echinoporæ, a type of superior gemmation, from the Gemmiporæ, a type of inferior gemmation; while a very close relation unites the Echinoporæ, Astræa argus and allied species, to the other Astræidæ. We find from the Meandrinæ that this subdivision of disks is a character of no importance; for although these zoophytes are so closely related to the dichastic Astræas, *no* subdivision takes place (§ 73) or only at very long intervals. The *actual distinction therefore consists in the disks widening by growth in some species, and in others the parts just exterior to the disks*,—a peculiarity of little physiological importance in these animals; for there are Astræas (A. stellulata) in which both modes of budding may be occasionally observed. There appears therefore to be sufficient reason for departing from the system of Ehrenberg, in which reproduction by subdivision of disks is considered a character of prime importance, and in accordance with which this distinguished author separates the Astræa argus and similar species from the genus Astræa, and arranges them with species of inferior gemmation.* In the classification we adopt, superior gemmation separates the Astræacea from the Caryophyllacea.†

79. The following tables present a review of the mode of growth, budding and branching, which have been described. And it will be perceived that the subject receives increased interest from the illustrations it affords of corresponding facts in the vegetable kingdom.

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* Ehrenberg places the Astræa argus, a foliated Gemmipora and some other species in the same genus, to which he has applied Lamarck's name, Explanaria.

† Other distinguishing characters will be hereafter given.

- **Polyps,**
  - **Growth not acrogenous,**
    - **Gemmation inferior,**
      - Budding and growth in a single direction laterally from the base, — 1. Linear.—*Zoanthæ.*
      - Budding laterally from the base in different directions,
        - Coalescent only at intervals, — 2. Reticulate.—*Auloporæ.*
        - Every way coalescent, — 3. Explanate or foliaceous, with prominent polyps if the coalescence does not extend to the summits of the polyps.
      - Polyps oblique and budding in erect or ascending lines.
        - Buds in simple or complex series, — 4. Erect stems with polyps facing in certain directions.—Many *Scrtularidæ.*
        - Buds alternate in direction, and thus forming a spiral series, — 5. Erect stems, polyps facing variously.—*Oculinæ.*
        - Budding from a cluster and not limited in direction, — 6. Erect stems, as in many *Gorgoniæ.* (These and the Oculinæ are at times somewhat acrogenous.)
    - Gemmation superior; polyps every way coalescent, — 7. Explanate, with the polyps but little or not at all prominent.–*Echinoporæ.*
  - **Growth acrogenous,**
    - **Buds not limited in direction,**
      - Unlimited by age,
        - Segregate, — 8. Globular or hemispherical, and consisting of tubular or calicular branches.—*Tubiporæ, Mussæ, Caryophylliæ.*
        - Aggregate, — 9. Globular or hemispherical, massive.—*Astræas,* &c.
      - Limited to the younger polyps, — 10. Columnar, or subcylindrical stems, with a budding cluster at apex.—Many *Porites, Pocilloporæ,* &c.
      - Limited to a single acrogenous polyp, which buds laterally and indefinitely, — 11. Cylindrical stems with a parent-polyp at apex.—*Madreporæ, Dendrophylliæ.* These become *horizontal* or oblique, when the polyps are developed unequally on two opposite sides, as in horizontally growing Madrepores, which, when the branches spread from a centre, are *vase-shape.*
    - Buds facing in two directions, and spreading laterally as well as upward, — 12. Vertical plates, some *Milleporæ.*

The branching of Zoophytes takes place :—1. By means of terminal shoots, from summit buds, periodical or not.
2. By means of lateral shoots, proceeding from a cluster of lateral polyps, assuming the gemmating function, (cumulato-ramose.)
3. By means of lateral shoots from a single lateral polyp becoming a parent-polyp, (patrio-ramose.)
4. By the furcation of a budding cluster owing to its enlargement, (furcato-ramose.)
5. By furcation, in certain segregate species, of a terminal polyp, arising from disk-budding, (Mussæ, Caulastrææ.)

Branching species are farther modified by coalescence, and become thus reticulate, laminate, or even massive, according to the extent of the coalescence.

We cite the following concluding remarks from the Report on Zoophytes, to which work reference may be made for fuller details on the various points which have been under consideration.

80. We thus perceive the principal steps by which corals take on their specific forms, and see reason for the fact that these forms are constant in the same species. The many varied shapes of zoophytes,—the tree, the shrub, the clustered leaves, globes and hemispheres, clubs, twigs, and coral network,—require for their explanation only the few principles here adduced. The germ-polyp, growing upward and budding as it grows, gives rise to the various branching and nodular zoophytes, while by growth laterally, the *explanate* or oblique foliated species originate. In the upward mode of growth, when all the polyps bud equally, globes and hemispheres are produced; but if the gemmating power is retained only by the recent polyps, the zoophyte lengthens into stems and cylinders. When, in this last process, budding takes place symmetrically, the zoophyte is erect; if unsymmetrical, it is oblique or horizontal; and the zoophyte, when erect, is cylindrical or a flattened plate, according as buds form alike on all sides of a centre, or open in two opposite directions. In some acrogenous species, there is a terminal polyp,—*parent-polyp*,—from which the buds proceed; in others, a terminal *cluster of polyps*. The *former*, ramify by lateral shoots, common polyps changing to parent-polyps, and thus becoming the germs of branches, which take their direction from the position of the budding-polyp; the *latter*, branch generally by furcation at summit, the size of the terminal cluster determining the diameter of the branch, and indirectly occasioning the furcation.

In other species still, each polyp gives out its single polyp in succession, and the continued accumulation produces the rising stem, which ramifies either by the processes just mentioned, or from buds at apex, forming periodically and becoming the germs of branches.

There is much to surprise and interest us in tracing out the simple causes of results so remarkable. The small polyp, incapable even of extending its arms without a drop of water to inject them, is enabled, by means of a simple secretion in its texture, in connexion with the process of budding, to rise from the rock and spread wide its branches, or erect, with solid masonry, the coral domes, in defiance of the waves that break over them. The microscopic germ of a Gorgonia developes a polyp barely visible to the naked eye, which has the power of producing a secretion from its base. The polyp buds, and finally the growing shrub is covered with branches and branchlets, many a mere thread in thickness, which stand and wave unhurt in the agitated waters. The same secretions fix it to its support, and so strongly, that even the rock comes away before the zoophyte will break

from its attachment. Tens of thousands of polyps cover the branches, like so many flowers, spreading their tinted petals in the genial sunshine, and quiet seas, but withdrawing when the clouds betoken a storm.

"Excelsior," is the grave motto of the zoophyte. Ever upward, they continue growing and elongating, although death is at work below, with as rapid progress. A beautiful provision protects the branching coral-tree—often the work of ages—from being destroyed by the dissolving waters, when exposed, on the death and removal of the polyps. Certain minute incrusting corals—the Bryozoa and Sertularidæ, together with Nullipores—make the surface their resting place, as soon as it is laid bare, and go on spreading and covering the dead trunk, and so prevent the wearing action of the sea. The Madrepore may thus continue to enlarge beyond its adult size; the Caryophyllia may multiply almost endlessly its cylindrical branchings, although the living animal but tips the extremities of each: for protection is given at once, when needed, and the polyps die, only to leave the surface to other forms of life, more varied and no less strange.

Finally, the coral becomes subservient to a still higher purpose than the support of polyps and nullipores. The debris, produced by the waves over a reef, settles into the many crevices among the dead trunks, and fills up the intervals, often large, between the scattered coral-patches; and, by this combined action of living growth and detritus accumulations, a solid rocky basement is formed, and kept in constant increase. In this way the coral reef gradually nears the surface, and finally becomes the foundation of one of the fairest of

> "The sea-girt isles,
> That, like to rich and various gems, inlay
> The unadorned bosom of the deep;"

the coral polyps now yield place to the flowers and groves of the land, which fulfill their end in promoting the comfort and happiness of man.

*Note.*—The figures illustrating this article represent the following species of corals.

Fig. 13. Polyp of the *Mussa cactus* (D), natural size. Allied to the *Caryophyllia carduus* of Lamarck, (genus *Lobophyllia* of Blainville.)

Fig. 14. The *Astræa purpurea* (D), alive and expanded; natural size.

Fig. 15. Part of a branch of the *Madrepora cribripora* (D), alive and expanded; natural size.

Fig. 16. Part of a branch of the *Dendrophyllia nigrescens* (D), alive and expanded; natural size.

Fig. 17. A lobe of the *Xenia florida*, probably the *Actinantha florida* of Lesson; natural size.

Fig. 18. A polyp of the *Tubipora fimbriata* (D), enlarged between three and four diameters.

Fig. 32. *Caryophyllia arbuscula.* (Lesueur.)

Fig. 34. Part of a branch of *Oculina varicosa.* (Lesueur.)

Fig. 35. Part of a branch of *Oculina pallens.* (Ehrenberg.)

Fig. 38. A branch of the *Caulastræa furcata.* (D.)

ART. II.—*On the Induction of Atmospheric Electricity on the Wires of the Electrical Telegraph;* by Prof. JOSEPH HENRY.*

THE action of the electricity of the atmosphere on the wires of the electrical telegraph, is at the present time a subject of much importance, both on account of its practical bearing, and the number of purely scientific questions which it involves. I have accordingly given due attention to the letter referred to me, and have succeeded in collecting a number of facts in reference to the action in question. Some of these are from the observations of different persons along the principal lines, and others from my own investigations during a thunder-storm on the 19th of June, when I was so fortunate as to be present in the office of the telegraph in Philadelphia, while a series of very interesting electrical phenomena was exhibited. In connexion with the facts derived from these sources, I must ask the indulgence of the society in frequently referring, in the course of this communication, to the results of my previous investigations in dynamic electricity, accounts of which are to be found in the Proceedings and Transactions of this Institution.

From all the information on the subject of the action of the electricity of the atmosphere on the wires of the telegraph, it is evident that effects are produced in several different ways.

1. The wires of the telegraph are liable to be struck by a direct discharge of lightning from the clouds, and several cases of this kind have been noticed during the present season. About the 20th of May, the lightning struck the elevated part of the wire, which is supported on a high mast at the place where the telegraph crosses the Hackensack river. The fluid passed along the wire each way, from the point which received the discharge, for several miles, striking off at irregular intervals down the supporting poles. At each place where the discharge to a pole took place, a number of sharp explosions were heard in succession, resembling the rapid reports of several rifles. During another storm, the wire was struck in two places in Pennsylvania, on the route between Philadelphia and New York; at one of these places twelve poles were struck, and at the other eight. In the latter case the remarkable fact was observed, that every other pole escaped the discharge; and the same phenomenon was observed, though in a less marked degree, near the Hackensack river. In some instances the lightning has been seen coursing along the wire in a stream of light; and in another case it is described as exploding from the wire at certain points, though

* Communicated by the author from the Proceedings of the American Philosophical Society, vol. iv, p. 269.

there were no bodies in the vicinity to attract it from the conductor.

In discussing these, and other facts to be mentioned hereafter, we shall, for convenience, adopt the principles and language of the theory which refers the phenomena of electricity to the action of a fluid, of which the particles repel each other, and are attracted by the particles of other matter. Although it cannot be affirmed that this theory is an actual representation of the cause of the phenomena as they are produced in nature, yet it may be asserted that it is, in the present state of science, an accurate mode of expressing the laws of electrical action, so far as they have been made out; and that though there are a number of phenomena which have not as yet been referred to this theory, there are none which are proved to be directly at variance with it.

That the wires of the telegraph should be frequently struck by a direct discharge of lightning, is not surprising, when we consider the great length of the conductor, and, consequently, the many points along the surface of the earth through which it must pass, peculiarly liable to receive the discharge from the heavens. Also, from the great length of the conductor, the more readily must the repulsive action of the free electricity of the cloud drive the natural electricity of the conductor to the farther end of the line, thus rendering more intense the negative condition of the nearer part of the wire, and, consequently, increasing the attraction of the metal for the free electricity of the cloud. It is not however, probable, that the attraction, whatever may be its intensity, of so small a quantity of matter as that of the wire of the telegraph, can of itself produce an electrical discharge from the heavens: although, if the discharge were started by some other cause, such as the attraction of a large mass of conducting matter in the vicinity, the attraction of the wire might be sufficient to change the direction of the descending bolt, and draw it in part or whole, to itself. It should also be recollected, that on account of the perfect conduction, a discharge on any part of the wire must affect every other part of the connected line, although it may be hundreds of miles in length.

That the wire should give off a discharge to a number of poles in succession, is a fact I should have expected, from my previous researches on the lateral discharge of a conductor transmitting a current of free electricity. In a paper on this subject, presented to the British Association in 1837, I showed that when electricity strikes a conductor explosively, it tends to give off sparks to all bodies in the vicinity, however intimately the conductor may be connected with the earth. In an experiment in which sparks from a small machine were thrown on the upper part of a lightning rod, erected in accordance with the formula given by the French Institute, corresponding sparks could be drawn from every

part of the rod, even from that near the ground. In a communication since made to this society, I have succeeded in referring this phenomenon to the fact, that during the transmission of a quantity of electricity along a rod, the surface of the conductor is charged in succession, as it were, by a wave of the fluid, which, when it arrives opposite a given point, tends to give off a spark to a neighboring body, for the same reason that the charged conductor of the machine gives off a spark under the same circumstances.

It might at first be supposed that the redundant electricity of the conductor would exhaust itself in giving off the first spark, and that a second discharge could not take place; but it should be observed, that the wave of free electricity, in its passage, is constantly attracted to the wire by the portion of the uncharged conductor which immediately precedes its position at any time; and hence but a part of the whole redundant electricity is given off at one place; the velocity of transmission of the wave as it passes the neighboring body, and its attraction for the wire, preventing a full discharge at any one place. The intensity of the successive explosions is explained by referring to the fact, that the discharge from the clouds does not generally consist of a single wave of electricity, but of a number of discharges along the same path in rapid succession, or of a continuous discharge which has an appreciable duration; and hence the wire of the telegraph is capable of transmitting an immense quantity of the fluid thus distributed over a great length of the conductor.

The remarkable facts of the explosions of the electricity into the air, and of the poles being struck in interrupted succession, find a plausible explanation in another electrical principle which I have established, namely, in all cases of the disturbance of the equilibrium of the electrical plenum, which we must suppose to exist throughout all terrestrial space, the state of rest is attained by a series of diminishing oscillations. Thus, in the discharge of a Leyden jar, I have shown that the phenomena exhibited cannot be explained by merely supposing the transfer of a quantity of fluid from the inner to the outer side of the jar; but in addition to this we are obliged to admit the existence of several waves, backwards and forwards, until the equilibrium is attained. In the case of the discharge from the cloud, a wave of the natural electricity of the metal is repelled each way from the point on which the discharge falls, to either end of the wire, is then reflected, and in its reverse passage meets in succession the several waves which make up the discharge from the cloud. These waves will therefore interfere at certain points along the wire, producing, for a moment, waves of double magnitude, and will thus enhance the tendency of the fluid at these points to fly from the conductor. I do not say that the effects observed were actu-

ally produced in this way; I merely wish to convey the idea that known principles of electrical action might, under certain circumstances, lead us to anticipate such results.

2. The state of the wire may be disturbed by the conduction of a current of electricity from one portion of space to another, without the presence of a thunder-cloud; and this will happen in case of a long line, when the electrical condition of the atmosphere which surrounds the wire at one place is different from that at another. Now it is well known that a mere difference in elevation is attended with a change in the electrical state of the atmosphere. A conductor, elevated by means of a kite, gives sparks of positive electricity in a perfectly clear day; hence, if the line of the telegraph passes over an elevated mountain ridge, there will be continually, during clear weather, a current from the more elevated to the lower points of the conductor.

A current may also be produced in a long level line, by the precipitation of vapor in the form of fog at one end, while the air remains clear at the other; or by the existence of a storm of rain or snow at any point along the line, while the other parts of the wire are not subjected to the same influence.

Currents of sufficient power to set in motion the marking machine of the telegraph have been observed, which must have been produced by some of these causes. In one case the machine spontaneously began to operate without the aid of the battery, while a snow storm was falling at one end of the line, and clear weather existed at the other. On another occasion, a continued stream of electricity was observed to pass between two points at a break in the wire, presenting the appearance of a gas-light almost extinguished. A constant effect of this kind indicates a constant accession of electricity at one part of the wire, and a constant discharge at the other.

3. The natural electricity of the wire of the telegraph is liable to be disturbed by the ordinary electrical induction of a distant cloud. Suppose a thunder-cloud, driven by the wind in such a direction as to cross one end of the line of the telegraph at the elevation, say of a mile; during the whole time of the approach of the cloud to the point of its path directly above the wire, the repulsion of the redundant electricity with which it is charged would constantly drive more and more of the natural electricity of the wire to the farther end of the line, and would thus give rise to a current. When the cloud arrived at the point nearest to the wire, the current would cease for a moment; and as the repulsion gradually diminished by the receding of the cloud, the natural electricity of the wire would gradually return to its normal state, giving rise to a current in an opposite direction. If the cloud were driven by the wind parallel to the line of the telegraph, a current would be produced towards each end of the

wire, and these would constantly vary in intensity with the different positions of the cloud. Although currents produced in this way may be too feeble to set in motion the marking apparatus, yet they may have sufficient power to influence the action of the current of the battery so as to interfere with the perfect operation of the machine.

4. Powerful electrical currents are produced in the wires of the telegraph by every flash of lightning which takes place within many miles of the line, by the action of dynamic induction; which differs from the action last described, in being the result of the influence of electricity *in motion* on the natural electricity of the conductor. The effect of this induction, which is the most fruitful source of disturbance, will be best illustrated by an account of some experiments of my own, presented to the society in 1843. A copper wire was suspended by silk strings around the ceiling of an upper room, so as to form a parallelogram of about sixty feet by thirty on the sides; and in the cellar of the same building, immediately below, another parallelogram of the same dimensions was placed. When a spark from an electrical machine was transmitted through the upper parallelogram, an induced current was developed in the lower one, sufficiently powerful to magnetize needles, although two floors intervened, and the conductors were separated to the distance of thirty feet. In this experiment no electricity passed through the floors from one conductor to the other; the effect was entirely due to the repulsive action of the electricity in motion in the upper wire on the natural electricity of the lower. In another experiment, two wires, about 400 feet long, were stretched parallel to each other between two buildings; a spark of electricity sent through one produced a current in the other, though the two were separated to the distance of 300 feet; and from all the experiments, it was concluded that the distance might be indefinitely increased, provided the wires were lengthened in a corresponding ratio.

That the same effect is produced by the repulsive action of the electrical discharge in the heavens, is shown by the following modification of the foregoing arrangement. One of the wires was removed, and the other so lengthened at one end, as to pass into my study, and thence through a cellar window into an adjacent well. With every flash of lightning which took place in the heavens, within at least a circle of twenty miles around Princeton, needles were magnetized in the study by the induced current developed in the wire. The same effect was produced by soldering a wire to the metallic roof of the house, and passing it down into the well; at every flash of lightning a series of currents in alternate directions was produced in the wire.

I was also led, from these results, to infer that induced currents must traverse the line of a railroad, and this I found to be

the case. Sparks were seen at the breaks in the continuity of the rail, with every flash of a distant thunder-cloud.

Similar effects, but in a greater degree, must be produced on the wire of the telegraph, by every discharge in the heavens; and the phenomena which I witnessed on the 19th of June in the telegraph office in Philadelphia, were, I am sure, of this kind. In the midst of the hurry of the transmission of the congressional intelligence from Washington to Philadelphia, and thence to New York, the apparatus began to work irregularly. The operator at each end of the line announced at the same time a storm at Washington, and another at Jersey City. The portion of the circuit of the telegraph which entered the building, and was connected with one pole of the galvanic battery, happened to pass within the distance of less than an inch of the wire which served to form the connexion of the other pole with the earth. Across this space, at an interval of every few minutes, a series of sparks in rapid succession was observed to pass; and when one of the storms arrived so near Philadelphia that the lightning could be seen, each series of sparks was found to be simultaneous with a flash in the heavens. Now we cannot suppose, for a moment, that the wire was actually struck at the time each flash took place; and indeed it was observed that the sparks were produced when the cloud and flash were at the distance of several miles to the east of the line of the wire. The inevitable conclusion is, that all the exhibition of electrical phenomena witnessed during the afternoon, was purely the effect of induction, or the mere disturbance of the natural electricity of the wire at a distance, without any transfer of the fluid from the cloud to the apparatus.

The discharge between the two portions of the wire continued for more than an hour, when the effect became so powerful, that the superintendent, alarmed for the safety of the building, connected the long wire with the city gas pipes, and thus transmitted the current silently to the ground. I was surprised at the quantity and intensity of the current; it is well known, that to affect a common galvanometer with ordinary electricity, requires the discharge of a large battery; but such was the quantity of the induced current exhibited on this occasion, that the needle of an ordinary vertical galvanometer, with a short wire, and apparently of little sensibility, was moved several degrees.

The pungency of the spark was also, as might have been expected, very great. When a small break was made in the circuit, and the parts joined by the fore-finger and thumb, the discharge transmitted through the hand affected the whole arm up to the shoulder. I was informed by the superintendent, that on another occasion a spark passed over the surface of the spool of wire, surrounding the legs of the horse-shoe magnet at right an-

gles to the spires; and such was its intensity and quantity, that all the wires across which it passed were melted at points in the same straight line as if they had been cut in two by a sharp knife.

The effects of the powerful discharges from the clouds may be prevented in a great degree, by erecting at intervals along the line, and aside of the supporting poles, a metallic wire, connected with the earth at the lower end, and terminating above at the distance of about half an inch from the wire of the telegraph. By this arrangement the insulation of the conductor will not be interfered with, while the greater portion of the charge will be drawn off. I think this precaution of great importance at places where the line crosses a river, and is supported on high poles. Also in the vicinity of the office of the telegraph, where a discharge, falling on the wire near the station, might send a current into the house of sufficient quantity to produce serious accidents. The fate of Prof. Richman, of St. Petersburg, should be recollected, who was killed by a flash from a small wire, which entered his house from an elevated pole, while he was experimenting on atmospheric electricity.

The danger, however, which has been apprehended from the electricity leaving the wire and discharging itself into a person on the road, is, I think, very small; electricity of sufficient intensity to strike a person at the distance of eight or ten feet from the wire, would, in preference, be conducted down the nearest pole. It will, however, in all cases, be most prudent to keep at a proper distance from the wire during the existence of a thunder storm in the neighborhood.

It may be mentioned as an interesting fact, derived from two independent sources of information, that large numbers of small birds have been seen suspended by the claws from the wire of the telegraph. They had, in all probability, been instantaneously killed, either by a direct discharge, or an induced current from a distant cloud, while they were resting on the wire.

Though accidents to the operators, from the direct discharge, may be prevented by the method before mentioned, yet the effect on the machine cannot be entirely obviated; the residual current which escapes the discharge along the perpendicular wires, must neutralize, for a moment, the current of the battery, and produce irregularity of action in the apparatus.

The direct discharge from the cloud on the wire is, comparatively, not a frequent occurrence, while the dynamic inductive influence must be a source of constant disturbance during the season of thunder storms; and no other method presents itself to my mind at this time for obviating the effect, but that of increasing the size of the battery, and diminishing the sensibility of the

magnet, so that, at least, the smaller induced currents may not be felt by the machine. It must be recollected, that the inductive influence takes place at a distance through all bodies, conductors and non-conductors; and hence no coating that can be put upon the wire will prevent the formation of induced currents.

I think it not improbable, since the earth has been made to act the part of the return conductor, that some means will be discovered for insulating the single wire beneath the surface of the earth; the difficulty in effecting this is by no means as great as that of insulating two wires, and preventing the current striking across from one to the other. A wire, buried in the earth, would be protected, in most cases, from the effect of a direct discharge; but the inductive influence would still be exerted, though perhaps in a less degree.

The wires of the telegraph are too small and too few in number to affect, as some have supposed, the electrical condition of the atmosphere, by equalizing the quantity of the fluid in different places, and thus producing a less changeable state of the weather. The feeble currents of electricity which must be constantly passing along the wires of a long line, may, however, with proper study, be the means of discovering many interesting facts relative to the electrical state of the air over different regions.

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ART. III.—*A New Mineral from the Azores;* by J. E. TESCHEMACHER.

IN examining a portion of a volcanic boulder from St. Michael's, Azores, for specimens of Pyrrhite, I discovered several small crystals, apparently octahedrons, of a translucent slightly yellowish white color, which alone before the blowpipe were totally infusible; on farther examination they proved to be nearly pure columbate of lime. The following is a description of them.

Form—a square prism terminated by four-sided pyramids.

M on *c* = 133·40
*c* " *c* = 123·15
M " M′ = 90
} by the reflecting goniometer.

Nearly all the crystals are in the form of obtuse octahedrons, the vertical axis being shorter than the lateral; one or two were found with prisms about the height of the pyramids—these were measured.*

The color is usually translucent to opake white, with a very faint greenish yellow tinge; one or two were however as clear as fine quartz; these were probably pure columbate of lime.

* Specimens of this mineral, received through the kindness of Mr. Teschemacher, correspond entirely to the description above given.—*J. D. D.*

Fracture vitreous—no trace of cleavage. The largest crystal is only 1½ lines at the base of the pyramid.

Before the blowpipe alone, the small pure crystals become opake white; those larger and more colored acquire in the outer flame a distinct red color, *partially* disseminated in the interior of the crystal. This color disappears in the reducing flame, the whole becoming of a very light sulphur yellow; the red color is reproduced by exposure to the outer flame, after cooling, and again disappears in the reducing flame; this alternation takes place as often as desired. The edges are not even rounded.

With borax on the platina wire, the crystals in the hottest reducing flame dissolve with extreme slowness and difficulty; the globule is quite transparent, sometimes exhibiting a very faint greenish tint. When the globule is saturated with the mineral, it becomes opake white by flaming. On the addition of peroxyd of iron to the globule, it gives the usual green color of a ferruginous oxyd. These characters do not permit a doubt of its being a columbic acid mineral.

Phosphoric salt dissolves the crystals slowly, a faint green tint becoming apparent; this indicates a trace of uranium.

The powdered mineral is decomposed on fusing with bisulphate of potash, and the addition of hydrochloric acid precipitates columbic acid. On removing the acid liquor by the filter, and immersing in it a crystal of bisulphate of potash, flocculent crystals of sulphate of lime appear.

The mineral, therefore, like Pyrochlore, is a columbate of lime, but as there can be no doubt that this latter is a regular octahedron, there must be some cause for the difference in their forms. This may either arise from a change produced by a chemical combination of some of the other ingredients of Pyrochlore, or from this new mineral being columbic acid in a different state of saturation by lime, from that in Pyrochlore. Either of these cases is of much interest to the chemist and mineralogist, and I regret that the quantity found is so small as for the present to preclude regular chemical analyses of this beautiful though microscopic mineral. It seems most probable, as far as we can judge from the examinations, that it is a case of dimorphism.

The characters of Pyrrhite before the blowpipe were examined at the same time, and confirm my previous opinion of its titanic composition. On the addition to its solution in the borax globule of a portion of peroxyd of iron, it gives the usual reddish brown glass indicative of titanium.

I am indebted to my friend Dr. A. A. Hayes, for a careful examination and confirmation of the blowpipe characters, as well as for the chemical reactions.

There is so great a similarity in the occurrence of this crystallized columbate of lime in the volcanic boulders of the Azores,

and that of Pyrochlore in the vein in granite at Chesterfield, that a comparison of the two seems worthy of notice; premising, however, that I have examined too small a quantity of the St. Michael's rock, to arrive at any conclusions of consequence.

*Chesterfield, Massachusetts.*

A large vein of granite in mica slate, lying nearly in the direction of the slate, obliquely crossed by a vein of the following contents.

Albite—chief ingredient, the quartz appearing mostly aggregated in the central part of the vein.

Tourmaline—red, green, blue and black, in considerable quantity, often in small crystals.

Mica—quantity very moderate.

Pyrochlore—(columbate of lime)—quantity very small.

Damourite, Columbite, Uranium } extremely rare.

Titanium—a trace sometimes in the Pyrochlore.

Professor Hitchcock does not give the bearings of these eruptive veins, and I have not visited the locality.

*St. Michael's, Azores.*

Contents of volcanic boulders.

Albite—chief constituent.

Tourmaline—black, in considerable quantity. Crystals small.

Mica—a trace.

Columbate of lime, the mineral described in this paper, quantity very small, but containing a trace of Uranium.

Titanium—Pyrrhite, quantity very small.

There is another volcanic rock from this locality, in which the Albite is replaced by Ryakolite, and the octahedral Pyrrhite by a titanium mineral of a different form.

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ART. IV.—*On the Delta and Alluvial Deposits of the Mississippi, and other points in the Geology of North America, observed in the years* 1845, 1846; by C. LYELL.*

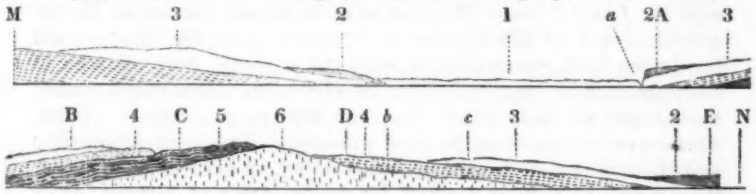
THE delta of the Mississippi may be defined as that part of the great alluvial plain which lies below, or to the south of the branching off of the highest arm of the river, called the Atchafalaya. This delta is about 13,600 square miles in area, and elevated from a few inches to ten feet above the level of the sea. The greater part of it protrudes into the Gulf of Mexico beyond the general coast line. The level plain to the north, as far as Cape Girardeau in Missouri above the junction of the Ohio, is of the same character, including, according to Mr. Forshey, an area of about 16,000 square miles, and is, therefore, larger than the delta. It is very variable in width from east to west, being near its northern extremity, or at the mouth of the Ohio, 50 miles wide; at Memphis 30; at the mouth of the White River 80, and contracting again farther south, at Grand Gulf, to 33 miles. The delta and alluvial plain rise by so gradual a slope from the sea as to attain, at the junction of the Ohio, (a distance of 800 miles by the river,) an elevation of only two hundred

* Abstract of a discourse before the British Association, Sept. 14, 1846, from the Athenæum, for September 26.

feet above the Gulf of Mexico. Mr. Lyell first described the low mud banks covered with reeds at the mouths of the Mississippi, and the pilot-station called the Balize; then passed to the quantity of drift wood choking up the bayous, or channels, intersecting the banks; and, lastly, enlarged on the long narrow promontory formed by the great river and its banks between New Orleans and the Balize. The advance of this singular tongue of land has been generally supposed to have been very rapid, but Mr. Lyell and Dr. Carpenter, who accompanied him, arrived at an opposite conclusion. After comparing the present state of this region with the map published by Charlevoix, 120 years ago, they doubt whether the land has, on the whole, gained more than a mile in the course of a century. A large excavation, eighteen feet deep, made for the gas works at New Orleans, and still in progress, March, 1846, shows that much of the soil there consists of fine clay or mud, containing innumerable stools of trees, buried at various levels in an erect position, with their roots attached, implying the former existence there of fresh-water swamps covered with trees, over which the sediment of the Mississippi was spread during inundations, so as slowly to raise the level of the ground. As the site of the excavation is now about nine feet above the sea, the lowest of these upright trees imply that the region where they grew has sunk down about nine feet below the sea level. The exposure, also, in the vertical banks of the Mississippi at low water for hundreds of miles above the head of the delta, of the stumps of trees buried with their roots in their natural position, three tiers being occasionally seen one above the other, shows that the river in its wanderings has opened a channel through ancient morasses, where trees once grew, and where alluvial matter gradually accumulated. The old deserted beds, also, of the river, with banks raised fifteen feet above the adjoining low grounds, bear testimony to the frequent shifting of the place of the main stream; and the like inference may be drawn from the occurrence, here and there, of crescent-shaped lakes, each many miles in length and half a mile or more in breadth, which have once constituted great curves or bends of the river, but are now often far distant from it. The Mississippi, by the constant undermining of its banks, checks the rise of large commercial towns on its borders, and causes a singular contrast between the wealth and splendor of eight hundred or more fine steamers, some of which may truly be called floating palaces, and the flat monotonous wilderness of uncleared land which extends for hundreds of miles on both sides of the great navigable stream. Mr. Lyell visited, in March, 1846, the region shaken for three months in 1811, 12, by the earthquake of New Madrid. One portion of it, situated in the States of Missouri and Arkansas, is now called "the sunk country." It extends about seventy miles

north and south, and thirty east and west, and is for the most part submerged. Many dead trees are still standing erect in the swamps, a far greater number lie prostrate. Even on the dry ground in the vicinity, all the forest trees which are of prior date to 1811, are leafless: they are supposed to have been killed by the loosening of their roots by the repeated shocks of 1811, 12. Numerous rents are also observable in the ground where it opened in 1811; and many "sink holes," or cavities, from ten to thirty yards wide and twenty feet or more in depth, now interrupt the general level of the plain, which were formed by the spouting out of large quantities of sand and mud during the earthquake. In attempting to compute the minimum of time required for the accumulation of the alluvial matter in the delta and valley of the Mississippi, Mr. Lyell referred to a series of experiments, made by Dr. Riddell, at New Orleans, showing that the mean annual proportion of sediment in the river was, to the water $\frac{1}{1\,2\,4\,3}$ in weight, or about $\frac{1}{3\,0\,0\,4}$ in volume. From the observations of the same gentleman, and those of Dr. Carpenter, and of Mr. Forshey, (an eminent engineer of Louisiana,) the average width, depth, and velocity of the Mississippi, and thence the mean annual discharge of water, are deduced. In assuming 528 feet (or the tenth of a mile) as the probable thickness of the deposit of mud and sand in the delta, Mr. Lyell founds his conjecture on the depth of the Gulf of Mexico, between the southern point of Florida and the Balize, which equals on an average 100 fathoms. The area of the delta being about 13,600 square statute miles, and the quantity of solid matter annually brought down by the river 3,702,758,400 cubic feet, it must have taken 67,000 years for the formation of the whole; and if the alluvial matter of the plain above be 264 feet deep, or half that of the delta, it has required 33,500 more years for its accumulation,—even if its area be estimated as only equal to that of the delta, whereas it is, in fact, larger. If some deduction be made from the time here stated, in consequence of the effect of drift wood, which must have aided in filling up more rapidly the space above alluded to, a far more important allowance must be made, on the other hand, for the loss of matter, owing to the finer particles of mud not settling at the mouth of the river, but being swept out far to sea, and even conveyed into the Atlantic by the Gulf Stream. Yet the whole period during which the Mississippi has transported its earthy burthen to the ocean, though perhaps far exceeding 100,000 years, must be insignificant, in a geological point of view, since the bluffs or cliffs bounding the great valley, (and therefore older in date,) and which are from 50 to 250 feet in perpendicular height, consist in great part of loam, containing land, fluviatile, and lacustrine shells of species still inhabiting the same country. These fossil shells, occurring in a deposit resembling the *loess* of the

Rhine, are associated with the bones of the mastodon, elephant, tapir, mylodon, and other megatherioid animals; also a species of horse, ox, and other mammalia, most of them of extinct species. The loam rests at Vicksburg and other places on eocene or lower tertiary strata, which in their turn, repose on cretaceous rocks. A section from Vicksburg to Darien, through the States of Mississippi, Alabama and Georgia, exhibits this superposition, as well




Section (M to N) about 750 miles in length from west to east, from Louisiana (on the west) through Jackson, Mississippi, to Tuscaloosa, in Alabama, and thence, by Montgomery, to the Atlantic, near Darien, in Georgia.*

as that of the cretaceous strata on carboniferous rocks at Tuscaloosa. Mr. Lyell ascertained that the huge fossil cretacean, named Zeuglodon, by Owen, is confined to the eocene deposits. In the cretaceous strata, the remains of the mosasaurus, and other reptiles, occur without any cetacea.

The coal-fields of Alabama were next alluded to; from which fossil plants have been procured, by Prof. Brumby and Mr. Lyell, of the genera Sphenopteris, Neuropteris, Calamites, Lepidodendron, Sigillaria, Stigmaria, and others, most of them identical in *species*, as determined by Mr. C. Bunbury, with fossils of Northumberland. This fact is the more worthy of nôtice, because the coal of Tuscaloosa—situated in lat. 33° 10′ N.—is farther south than any region in which this ancient fossil Flora had previously been studied, whether in Europe or North America; and it affords, therefore, a new proof of the wide extension of a uniform Flora in the carboniferous epoch. Mr. Lyell—adverting to the opinion recently adopted by several able botanists, that the climate of the coal period was remarkable for its moisture, equability, and freedom from cold, rather than the intensity of its tropical heat—stated that this conclusion, as well as the oscillations of temperature implied by the glacial period, are confirmatory of the theory first advanced by him, in 1830, to explain the ancient geological changes of climate, by

* 1. The alluvium of the Mississippi.—2. Post-pliocene loam and sand, with recent shells and bones of extinct mammalia; the shells in this deposit, on the borders of the valley of the Mississippi, are of land and fresh-water species, those near Darien, of marine species.—3. Eocene formation.—4. Cretaceous strata.—5. Carboniferous rocks.—6. Hypogene or granite, gneiss, mica schist, &c.

M to *a*. Louisiana.—A. Vicksburg, Mississippi.—B. Jackson.—C. Tuscaloosa, Alabama.—D. Montgomery.—E. Darien, Georgia.—N. Atlantic.

*a*. Mississippi river.—*b*. Chatahoochie river.—*c*. Flint river.

geographical revolutions in the position of land and sea. The lapse of ages, implied by the distinctness of the fossils of the eocene, cretaceous, carboniferous, and other strata, is such, that, were we to endeavor to give an idea of it, we must estimate its duration, not by years, as in the case of the delta, but by such units as would be constituted by the interval between the beginning of the delta and our own times. "It is now fifty years," said Mr. Lyell, "since Playfair, after studying the rocks in the neighborhood of Edinburgh, in company with Dr. Hutton and Sir James Hall, was so struck with the evidence they afforded of the immensity of past time, that he observed, 'How much farther reason may go, than imagination can venture to follow!' These views were common to the most illustrious of his contemporaries; and since that time have been adopted by all geologists, whether their minds have been formed by the literature of France, or of Germany, or of Italy, or Scandinavia, or England;—all have arrived at the same conclusion respecting the great antiquity of the globe, and that, too, in opposition to their earlier prepossessions and to the popular belief of their age. It must be confessed that, while this unanimity is satisfactory as a remarkable test of truth, it is somewhat melancholy to reflect, that, at the end of half a century, when so many millions have passed through our schools and colleges since Playfair wrote that eloquent passage, there is still so great a discordance between the opinions of scientific men and the great mass of the community. Had there been annual gatherings, such as this, where those who are entitled to speak with authority, address themselves to a numerous assembly, drawn from the higher classes of society, who, by their cultivation and influence, must direct the education and form the opinions of the many of humbler station, it is impossible that so undesirable and unsound a state of things should have now prevailed as that where there is one creed for the philosopher and another for the multitude. Had there been meetings like this, even for a quarter of a century, we should already have gained for geology the same victory that has been so triumphantly won by the astronomer. The earth's antiquity, together with the history of successive races of organic beings, would have been ere this as cheerfully and universally acknowleged as the earth's motion, or the number, magnitude, and relative distances of the heavenly bodies. I am sure it would be superfluous if I were to declare, in an assembly like this, my deep conviction, which you —all of you—share, that the further we extend our researches into the wonders of creation in time and space, the more do we exalt, refine, and elevate our conceptions of the Divine Artificer of the Universe."—Mr. Lyell concluded this discourse by announcing his corroboration of the discovery, recently made by Dr. King, at Greensburg, thirty miles from Pittsburg, in Pennsyl-

vania, of the occurrence of fossil foot-prints of a large reptilian, in the middle of the ancient coal-measures. They project, in relief, from the lower surfaces of slabs of sandstone; and are also found impressed on the subjacent layers of fine unctuous clay. This is the first well-established example of a vertebrated animal, more highly organized than fishes, being met with in a stratum of such high antiquity.

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ART. V.—*Hybridity in Animals, considered in reference to the question of the Unity of the Human Species;* by SAMUEL GEORGE MORTON, M. D.*

(Read before the Academy of Nat. Sci. of Philadelphia, Nov. 4 and 11, 1846.)

PART I.

*Introductory Remarks.*

THE facts connected with hybridity in the inferior classes of animals, have an important bearing on one of the most interesting questions in Ethnography; and it is in reference to this question, that we now propose to arrange and review them.†

It was taught by Buffon, John Hunter, and other naturalists of the past century, and is yet assumed by some learned men of the present day, that the hybrid offspring of two distinct species of animals, are incapable of reproducing their kind; thus making hybridity the test of specific character. It follows, according to this supposed law of nature, that if mankind embraced several species, the intermixture of these would go no further than to produce a sterile hybrid variety. But since all the races are capable of producing, with each other, a progeny more or less fertile, it is inferred that they must all belong to one and the same species. This is the question at issue.

It may, at first view, appear superfluous to go over the whole ground of inquiry; but apart from its Ethnographic relations, it is my wish to call attention to a branch of science that has hitherto been singularly neglected, and perhaps more so than any other. Having sought in vain for some collective exposition of its details, I was at length induced to examine them for myself; and in now giving them publicity, I respectfully solicit, from

* In receiving this paper, we commit ourselves (as in other cases) to none of the opinions of the author. We may add, that we have no fear of discussion on any point in science. Facts are the markings of a Divine hand around and within us, and when studied in all their bearings, they lead in the end to the establishment of Truth.—*Eds.*

† Dr. James Cowles Prichard, the first Ethnographer of this or any age, has, with great care and candor, collected many of the following examples of hybridity, although to my view, they conflict strongly with his main position.—See *Researches into the Physical History of Mankind*, vol. i.

practical observers, any authenticated examples of an analogous kind, that may not be embraced in this memoir.

We shall merely further premise that naturalists have differed as to the import of the word *species*, but we know of no better definition than that which is expressed by "separate origin and distinctness of race, evinced by the constant transmission of some characteristic peculiarity of organization." The term *race* has been indefinitely and conveniently used in those instances in which it is difficult to decide whether an individual of any tribe of plants or animals, is a distinct species, or only a variety of some other species. Races are properly successions of individuals propagated from any given stock; and we agree with the learned Dr. Prichard, from whom we cite these definitions, that when races can be proved to possess certain primordial distinctions, which have been transmitted unbroken, they should be regarded as true species.*

Let us now proceed to examine the question before us, commencing with the larger mammiferous animals, and proceeding from these to birds, fishes, insects and plants.

*Equine Hybrids.*—The common mule, the progeny of the ass and mare, has been familiar to man since the days of Homer; and it is equally well known that with this animal, the hybrid born, as a general rule, begins and terminates. But the result appears to depend much on temperature; for in the south of Spain, mules have often been observed to produce young; and M. de la Malle observes that this phenomenon is frequent in hot climates, in which their period of gestation is twelve months, being the same as that of the mare. The same author quotes

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* Researches into the Physical History of Mankind, 3d ed, p. 105, 109.—For some highly interesting views of this question, and their practical application, see Prof. Haldeman's Enumeration of Fresh Water Mollusca, in Boston Jour. of Nat. Hist., 1844. Further researches into Ethnographic affinities, may render it probable that what are now termed the *five races* of men, would be more appropriately called *groups;* that each of these groups is again divisible into a greater or smaller number of primary races, each of which has expanded from an aboriginal nucleus or centre. Thus I conceive that there were several centres for the American group of races, of which the highest in the scale are the Toltecan nations, the lowest the Fuegians. Nor does this view conflict with the general principle, that all these nations and tribes have had, as I have elsewhere expressed it, a common origin; inasmuch as by this term is only meant an indigenous relation to the country they inhabit, and that collective identity of physical traits, mental and moral endowments, language, &c., which characterize all the American races. The same remarks are applicable to all the other human races; but in the present infant state of Ethnographic science, the designation of these primitive centres, is a task of equal delicacy and difficulty. I may here observe, that whenever I have ventured an opinion on this question, it has been in favor of the doctrine of *primeval diversities* among men,—an original adaptation of the several races to those varied circumstances of climate and locality, which, while congenial to the one are destructive to the other; and subsequent investigations have confirmed me in these views. See *Crania Americana*, p. 3; *Crania Ægyptiaca*, p. 37; and *Distinctive Characteristics of the Aboriginal Race of America*, p. 36.

from Columella, the remark of Mago, a Carthagenian agriculturalist, that in his country the fecundity of the mule was a frequent event, although it was regarded as a prodigy in Greece and Italy. He adds, that these mixed mules do not cross again with each other, but only with the primitive species that has given them birth.*

The ancients gave the name *ginnus* to the offspring of the mule with the mare, which appears to have been a common animal among the Romans, who called it also the *little mule*, (parvum mulum.†)

Prevost and Dumas, repeating the experiments of Lieuenhœck, assure us that the sterility of these mules in northern climates, depends on an absence of spermatic animalcules; but the latter must be present in hot countries, to explain the phenomena of reproduction.

The *Hinny*, on the other hand, is the offspring of the horse and a female ass—*Bardo ex equo et asinâ*—an animal of a very refractory disposition, and little esteemed, either in ancient or modern times; nor have I been able to obtain any facts in relation to its reproductiveness.

Again, when a male, derived from the cross "between the she ass and the male *onager*, (Equus onager,) is allowed to couple with the mare, the offspring is more docile than either parent, and unites the beauty of form and gentle disposition of the father with the strength and swiftness of his grandsire;"‡ whence the ancients preferred the onager to the ass for the production of mules, and Mr. Gliddon informs me this opinion is prevalent in Egypt, at the present day.

The Baron Cuvier informs us that he had seen the cross between the ass and zebra, and between the female zebra and horse.§

The ass is not the proximate species of the genus Equus, when compared with the horse; but that place is held, as Cuvier remarks, by the *dziggetai* of Asia, (*Eq. hemionus.*) And two distinguished naturalists, Mr. Bell and Mr. Gray, are even disposed to remove the ass to a separate genus. Without passing judgment on this question, I will merely observe, that in order to obtain a prolific breed of hybrid horses, the true horse should be coupled with the *hemionus*, under the same adaptation of climate and domesticity that have been bestowed on some other mixed animals; nor until this experiment has been fairly tried, can we speak with absolute certainty of the extent of productiveness of equine mules.

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* M. de la Malle, Ann. des Sciences Nat., xxvii, p. 235.
† M. de la Malle, ibid., p. 143.
‡ Columella, quoted *ut supra*, p. 135.
§ Regne animal, i, p. 182.

The phenomenon of productiveness has little or no limit among the true horses; whence it has been inferred that they all belong to one species; and that their various forms and colors are solely owing to the diversified circumstances in which they have been placed. But the researches of Hamilton Smith, have not only given rise to much doubt on this subject, but have adduced a surprising array of facts in favor of the opposite opinion.

We must refer to his learned and elaborate essay for the mass of evidence therein embodied; merely observing, on the present occasion, that he separates the horses into five primitive stocks, which appear to constitute "distinct, though osculating species, or at least races separated at so remote a period, that they claim to have been divided from the earliest times of our present Zoology."*

He adds, that some of these forms yet exist in the wild state on the table-lands of Central Asia, and that all of them were so constituted as to be fusible into a common, specific, but very variable stock, for the purposes of man; and he finally concludes, that if man had been necessitated to cultivate the zebras of South Africa, instead of the horses of Asia, he would have succeeded in amalgamating the three or four known species into one domestic animal, little inferior to the horse itself.†

It therefore becomes a reasonable supposition that some varieties of the horse now known to us, may be hybrid mixtures of proximate species; more especially, since the facts collected by Hamilton Smith, De Azara, and De la Malle, show conclusively that all the domestic horses were reclaimed from an original wild state.

*Bovine Hybrids.*—In the argument in question, the ox tribe has always been referred to as one of the strongest evidences of the operation of local causes in producing varieties of breed. But the parent type or stock is wholly unknown to naturalists; and although it corresponds in its osteological structure with a fossil species (Bos urus) found throughout Europe, it is extremely doubtful whether all the modifications now familiar to man are derived from this animal. "An opinion has lately been started," observes a learned zoologist, "that the haunched varieties of cattle, are derived from a different species; against which no conclusive ob-

* Natural History of the Equidæ, p. 154.

† Ibid, p. 75, 183. Fossil remains of the horse, and especially the teeth, have been of late years abundantly found in Europe and Asia, and in North and South America; (and especially near Natchez, by Dr. Dickerson;) showing that this animal was once indigenous to all these widely extended regions; and yet there are now no horses in the Western Hemisphere, excepting those that have descended from the European stock. The indigenous species must have become extinct from some remote and extended cataclysm. It is curious, also, to note that these fossil horses were different in species from the present variety, although they were closely allied to it. There were in ancient times several, perhaps many, species of the genus Equus.

jection can well be made, when it is considered that the Gayal (Bos gavæus) produces a mixed race with the domestic animal; and that the yak of Tartary, (Bos grunniens,) and even the American bison, are equally reported to mix with that species, notwithstanding their anatomical differences, and that the times of gestation are not similar."*

The hybrid offspring of the buffalo and the common breed of cattle, is now familiar in the western parts of the United States, particularly in Missouri and Kentucky; but I have not been informed whether they have ever bred away among themselves, or with either of the parent stocks. I have instituted inquiries on this subject, the results of which I hope to add as a sequel to this memoir. In fact, it is now conceded that all the species of the genus Bos are similarly circumstanced †; whence we have no difficulty in supposing that among the ox tribe, as among various other classes of animals, hybridity has more or less modified their forms during the long lapse of thousands of years.

*Bovine and Cervine Hybrid?*—The Baron Larrey incidentally mentions in his memoirs, the following circumstance that occurred during his residence at the Bay de Croc, in Newfoundland: "The *Carabon* (Cervus Wapiti) sometimes comes near the houses. In the night, one of them broke into our sheep-fold, where we had a cow, that became pregnant by him. She no doubt produced a mongrel; but I lost the opportunity of ascertaining the fact, because she was taken back to Brest."‡

I see no reason to question any part of this statement, which ceases to astonish us when we regard the many analogous phenomena that are now fully authenticated, and among others the following very remarkable one.

*Bovine and Ovine Hybrid.*—In the article on hybridity, in Brande's Dictionary of Literature and Science,§ it is mentioned, without doubt or reservation, that a mule has been obtained between the bull and sheep; a statement that claims our entire credence, from the circumstance that the physiological part of the work in which it is contained, is from the pen of Prof. Owen, of the Royal College of Surgeons.

*Cervine Hybrids.*—The only example of this class that I have met with in authors, is that between the Indian buck of the Axine species, (Cervus axis,) with the Porcine species, thus giving rise to the well known intermediate stock, called the *Spotted Hog-deer.*‖

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* Griffith's Cuvier, iv, p. 419.—Prichard's Researches, i, p. 190.
† Loudon's Magazine of Nat. Hist., ix, p. 511.
‡ Memoirs of Military Surgery, &c., Dr. Hall's trans., vol. i, p. 11.
§ Article *Hybrid.*
‖ Hamilton Smith, Æquidæ, p. 341.

*Caprine Hybrids.*—The goat called the *wild ægagrus*, which is found in all the Alpine regions of Europe and Asia, appears in every instance to be a prolific hybrid between the domestic goat and the local wild one of the country it inhabits, although the latter animal may be the *ibex*, the *caucasica*, or any other species.*

A mixed breed has also been obtained between the chamois (Antilope rupicapra) and the common goat.†

*Ovine Hybrids.*—It was until lately supposed by most zoologists, that the domestic sheep, and the Asiatic and American *Argali*, were mere varieties of one species; but they are now known to be distinct, and are severally designated by the names of *Ovis musmon*, *O. ammon* and *O. pygargus*. The common sheep, called in the systems, *O. aries*, is generally classed as a variety of the first named species; but recent investigations render it more than probable that several wild species have commingled to form the numerous cultivated races.‡

This view is to a certain degree sustained by a hybrid product recently obtained in Paris, between a wild *moufflon* (species not mentioned) and the common sheep; but as this result dates with the present year, the productive faculty of the intermediate animal had not been tested.§

*Ovine and Caprine Hybrids.*—The ancients, more especially the Romans, regarded all the varieties of domestic sheep as a mixed offspring of the sheep and goat, (*Capra hircus.*) The possibility of this union was proved by Prof. Pallas, by personal observation during his travels in Russia; and although a doubt has been here and there expressed with respect to it, the fact is now conceded by all naturalists from abundant evidence. Some new and very interesting information has lately been afforded us from another quarter. "For a very long time," observes M. Chevreul, "an extensive commerce has been carried on in Chili, in the skins of sheep with rather coarse wool, derived from a cross between the male of the common goat and the ewe, which was obtained as follows: a single goat was placed with six ewes, and male hybrids were obtained with a hairy fleece, which was little esteemed for the particular purpose for which it was designed. But by coupling these male hybrids with ewes, the latter were fruitful, and their offspring bore a fine, soft fleece, which is highly valued in the manufacture of *shabraques*, called also *pellians*, in Chili. After several generations, the hair becomes coarse and hard, when it becomes necessary to recur to a male hybrid of a former generation, in order to obtain the requisite cross for the production of the perfect fleece.‖

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* Hamilton Smith, Æquidæ, p. 341.
† Idem.
‡ Idem, p. 70.—Blyth, Proceedings of the Zoolog. Soc. of London, 1840.
§ Chevreul, Journal des Savants, Juin, 1846, p. 357.
‖ Journal des Savants, Juin, 1846, p. 357.

I have only to add, on the same authority, that Prof. Flourens, of Paris, has recently obtained a cross between the wild ram* (Ovis musmon ?) and the female of the common goat.

*Cervine and Ovine Hybrid.*—Hellenius, quoted by Rudolphi, mentions the very interesting case of a Sardinian doe that refused the goat, but was crossed by a ram. The young had the figure of the father, but in color more resembled the mother. These hybrids were again crossed by a Finland ram, and after a few generations assumed the characters of the Finland breed of sheep.†

*Cameline Hybrids.*—The two species of camel, *C. bactrianus* and *C. dromedarius*, produce with each other an intermediate offspring, which is said to be fertile without limit. Buffon could not deny this proverbial fact; and in order to obviate a difficulty that conflicted with a favorite opinion, he assumed that these animals must be mere varieties of a single species. Modern science, however, has established, beyond question, the specific differences of the camel and the dromedary.‡

*Canine Hybrids.*—If we could admit that all the dogs, with their varied external forms and peculiar instincts, have been derived from a single pair of these animals, we could have no difficulty, I conceive, in adopting so much of Lamarck's theory as relates to the progressive transmutation of species, resulting from what he calls the force of external circumstances; and it is curious to observe, that he especially adduces the canine race in support of his hypothesis. "In nature we seek in vain for mastiffs, harriers, spaniels, greyhounds, and other races between which the differences are so great that they *would be readily admitted as specific* among wild animals; yet all these have sprung originally from a single race, at first approaching very near to a wolf; if, indeed, the wolf be not the true type which at some period or other was domesticated by man."§

He further maintains that the peculiar instincts and functions of animals, the dogs for example, have not resulted from a previous and pre-adapted organization; but that these instincts, on the contrary, have developed by constant use those very organs of which they are the seat. The greyhound for example, has derived his long and slender legs, and his proverbial speed, from the mere habit of running with celerity in pursuing some animals and in escaping from others. The mastiff again has become large, strong and muscular, from habitually seizing and holding animals larger and stronger than himself. In fine, Lamarck applies the same principle to all organized beings, which according

* Moufflon. The particular species is not designated.
† Rudolphi, Beyträge zur Anthropologie, &c., p. 165.
‡ Cuvier, Regne animal, i, p. 187.
§ See Lyell's Principles of Geology, B. III, chap. 1, &c.

to his doctrine have been developed by the mere force of circumstances, a tendency to progressive advancement from the simplest to the most perfect forms. And here we may inquire, if education and domesticity can so vary not only the instincts but the very proportions of anatomical structure in dogs, do we not realize in the theory of Lamarck, a law of nature which would with equal readiness explain the unlimited transmutation of species into each other?

But is it proved that all the domestic dogs are really derived from a single species? Here again we appeal to one of the latest and best authorities on this question—Charles Hamilton Smith, whose laborious researches have led him to the following conclusions:—that the parents of our domestic dogs are derived from several distinct species, which were constituted with faculties to intermix, and thus to produce the interminable varieties familiar to man; that five of these types belong to the old world alone, viz. the *wolf*, the *buansu*, the *anthus*, the *dingo* and the *jackal;* that a *dhole* or a *thus* may have been the progenitor of the greyhound; and that the origin of the primitive mastiff may yet be traced to a lost or undiscovered species belonging to the hyena tribe.*

The wolf, the dog, the jackal and the fox, all intermix with each other. So does the common jackal with the jackal of Senegal. Do they therefore belong to one species? It is well known that the cross between the dog and the European wolf in the experiments of Buffon, did not extend beyond the fourth generation; but the distinguished writer whom we have just quoted, has observed, that the animals were in a state of neglect and restraint, and gradually tended to sterility from their small number, and from the want of recrossings from one or other of the parental stocks. It is worthy of remark, that the *dingo* of Australia when placed in similar circumstances with the common dog, also becomes sterile in the fourth generation; whence, according to this test, the *dingo* is not a true dog, but some other species of the genus Canis.

The greatest number of mammæ in the common dog is ten, the smallest number, six; in the wild species they are always in pairs, and they never vary in a species. "To what other cause, then, can we ascribe the anomaly in domestic dogs, so justly as to an intermixture of species?"†

The dogs that have become wild in Paraguay, always hunt in packs, thus resuming the wolf-like instinct of their progenitors. Will it be said that this is a newly developed instinct? or is it not rather an old one that new wants have reproduced.

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* Natural History of the Dog, in Naturalist's Library, vol i, p. 104, *et passim*. The *Canis venatica* of Burchell, connects the dog with the hyena almost without an interval.

† Ibid, ii, p. 79.

It is therefore certain that dissimilar species of the dog tribe are capable of producing a fertile hybrid offspring; and if it was the interest of man again to cultivate and extend these mixed species, there is every probability that the race would become unlimited.

"Experiments show," observes Mr. Lyell, "that after repeated failures, the union of two recognized species may at last, under very favorable circumstances, give birth to a fertile progeny; and such circumstances," he adds, "the naturalist may conceive to have occurred again and again in the course of a great lapse of ages."*

Every one who is in the least degree acquainted with the natural history of dogs, knows that certain remarkable changes of color, and sometimes of form, take place in particular localities. These changes are usually attributed solely to climate, food, training, and other exterior agents. I do not deny the modifying action of such agents in these and other cases; but it is a reasonable subject of inquiry, whether there may not be something in these localities that favors an effort of nature to reproduce a primitive type? The localities to which we allude,† do not operate equally on all varieties of the dog tribe; which we might suppose would be the case if all the canine breeds were derived from a single stock or species. It is important in connection with this subject, to observe that all the pure Indian dogs of North America are of one variety, with erect ears, a wolfish aspect, and having a howl in place of a bark. Most naturalists agree in considering it a reclaimed wolf. The late Mr. Thomas Say, regarded it as the *canis latrans* or *howling wolf*, in a state of domestication. It is remarkable, when unmixed, for the uniformity of its characters, which are the same in every locality over thousands of miles in extent.‡ No varieties have arisen from it, excepting by crossing the breed with other dogs, when a hybrid is produced that is prolific without end. It is much to be regretted that so little is known of the history of the indigenous dogs of America,—a subject that affords a fine field for scientific inquiry.

While engaged in writing this memoir, I am assured by my friend Dr. M'Coy, an intelligent physician and naturalist, that in the interior of Pennsylvania, the common wolf, *C. lupus*, has been taken when young, and successfully trained to deer hunting. The difficulty, however, with these animals was, that they devoured the game, unless the sportsman was on the spot to pre-

* Principles of Geology, Book III, chap. 2.

† See Dr. Prichard's Natural History of Man, for an admirable exposition of these and all other facts on which the *analogical argument* is founded.

‡ Carver's Travels in North America, p. 417. See also the plates of the magnificent Atlas of the Prince de Wied's Travels in this country.

vent them. To obviate this fault, these wolves were crossed by the common dog; giving rise to a mixed breed, that combined the keener instinct of the wolf with the greater docility of the dog. Should these hybrids reproduce among themselves, or with either of the parental sources, how completely will the history of these animals illustrate the origin of the dog tribe, its primitive domestication, the crosses between different species, and the varieties that must have followed from such intermixture? I hope yet to be able to lay before the reader all the facts of this singular history.

*Surine Hybrids.*—Another domestic animal which presents remarkable varieties of form as well as of marking, is the hog; and these have also been attributed to a single species modified by immemorial domestication. Some new light, however, has recently been thrown on this branch of zoology by Mr. Eyton of London, who has compared the skeletons of the Chinese, the African,* and the English pig, and finds that while they agree in the number of cervical vertebræ, (as indeed all quadrupeds do,) there is a remarkable difference in each of the other classes of these bones. We have not space for details, except to observe that the dorsal vertebræ vary from thirteen to fifteen, the lumbar from four to six, and the caudal from thirteen to twenty. Now, as far as time and circumstances had allowed the experiment to proceed, these several animals bred freely with each other, and in the instance of the Chinese pig, the offspring is unquestionably fruitful.

Mr. Eyton very justly remarks, that the above three pigs must be considered as distinct species, or osteological characters can no longer be received as criteria of species; and Hamilton Smith has arrived at the conclusion, that there were three if not four original species, endued with powers of unlimited reproduction.

*Feline Hybrids.*—These animals, at least the domestic varieties, had long been regarded as of one species; but modern researches have established that the blue or Chartreuse cat, originally belonged to a distinct feline group; the Bengal cat of Pennant pertains to a second; while the tortoise-shell cat is believed to have sprung from a third group originally indigenous to South America.† I believe all these animals produce with each other a fertile offspring. It may be denied, however, that they belong to different species; but that the domestic cat was once of at least two species, seems now decided by the observation of Dr. Ruppell, who finds the embalmed cat of the Egyptians to cor-

* The *Sus æthiopicus* has even been removed to a separate genus by Cuvier—*Phascochœres*. See *P. Æliani* in Ruppell, Atlas zu der Reise in Nord-Afrika, p. 61.

† Hamilton Smith, Equidæ, p. 339.

respond to the *Felis maniculata** of Nubia, and not to the *Felis domestica*. Where then is the race of cats once so abundant in ancient Egypt? They have probably come down to us so blended with other species that their identity is lost.

De Azara states, in the forests of Paraguay the *Felis yaguarundi* and the *F. eyra*, both unite with the domestic cat; and he adds, that should these wild species become in time extirpated, and the mixed breed alone remain, the latter would be very naturally referred with all its varieties, to a single original species.†

Mixed breeds have also been obtained between the black leopard and the African species, and between the lion and the tigress. The latter cross which is much the more remarkable, produced three cubs, which were doing well at the time the facts were published.‡ We regret that no further particulars have come under our notice.

*Feline and Musteline Hybrid.*—A most remarkable instance of hybridity between the cat and an animal of a totally distinct genus, is described in the following account, which is published in several of the best scientific periodicals, and appears to be well authenticated. "A domestic cat disappeared from a house in Penza. After being absent some time, she returned; and within the regular time, produced four young ones, two of which strongly resembled the marten. Their claws were not retractile, as in the cat; and the snout was elongated, like that of the pine marten, (Mustela martes.) The two others of the same litter more nearly resembled the cat; as they had retractile claws and round heads. All of them had the black feet, tail and ears of the marten; and they killed birds and small animals more for the pleasure of destroying them than for food. The proprietor endeavored to multiply this race, and to prevent their intermixing with the domestic cats, in which he proved highly successful. In the space of a few years he reared more than a hundred of these animals. A specimen presented to the Imperial Society of Natural History of Moscow, was of the third or fourth generation, and it retained all the characters of the first."§

Professor Pallas has described and figured the *Perxsa cat*, which has long been suspected for a hybrid, although very prolific. It may yet prove to be the animal we have just described.

*Lepine Hybrid.*—Amoretti, quoted by Rudolphi, has published the history of a cross between the European or English rabbit, *Lepus cuniculus*, and the hare, *L. timidus*.‖

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* Atlas zu der Reise im Nordlichen Afrika, p. 4, tab. I. Prof. Bell has also decided that the *Felis catus*, found wild in the forests of Europe is different from both the domestic species.

† Quadrupeds of Paraguay, i, p. 174.

‡ Vide Griffith's Cuvier, ii, p. 448. 1827.

§ Loudon's Mag. of Natural History, ix, p. 616. Griffith's Cuvier, ii, p. 489.

‖ Rudolphi, Beyträge zur Anthropologie, etc., p. 165.

*Phocine Hybrid.*—Finally, among mammiferous animals, it remains to notice the singular fact discovered by the traveler Steller, and mentioned by Rudolphi, that the sea-lion, *Phoca jubata*, of Behring's island, produces young with the sea-bear, *P. ursina*. "I have no doubt of this fact," adds Prof. Rudolphi, "since Pallas speaks of Rudolphi with the greatest respect, and Telesius proved the accuracy of his observations."*

*(To be continued.)*

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ART. VI.—*Solution of a Mathematical Problem;* by O. ROOT.

A STRAIGHT line whose length is $(r)$ being so moved as always to terminate in the sides of a right angle, required the locus of its consecutive intersection.

The sides of the right angle being taken as the axes of co-ordinates, the equation of the line whose length is given will be

$$y=ax+b \qquad (1).$$

In this equation if we make $x=0$, we get $y=b$; when we make $y=0$, we get $x=-\frac{b}{a}$. These values of $xy$ squared, give

$$b^2+\frac{b^2}{a^2}=r^2 \qquad (2).$$ This solved for $(a)$ gives

$$a=\frac{b}{(r^2-b^2)^{\frac{1}{2}}} \qquad (3).$$

The value of $(a)$ in equation (3), substituted in equation (1) gives

$$y=\frac{bx}{(r^2-b^2)^{\frac{1}{2}}}+b \qquad (4).$$

If we differentiate equation (4) allowing $(b)$ only to vary, we shall get

$$\frac{dy}{db}=\frac{r^2x}{(r^2-b^2)^{\frac{3}{2}}}+1=0 \therefore b=r\left(1-\left(\frac{x}{r}\right)^{\frac{2}{3}}\right)^{\frac{1}{2}};$$

this value of $(b)$ substituted in equation (4) gives

$$y=r\left(1-\left(\frac{x}{r}\right)^{\frac{2}{3}}\right)^{\frac{3}{2}}, \text{ or by reduction,}$$

$$y^{\frac{2}{3}}+x^{\frac{2}{3}}=r^{\frac{2}{3}} \qquad (5),$$

which is the equation of the required locus, and is the hypocycloid, the radius of whose base circle is $(r)$ the length of the given line, and the radius of its generating circle $\frac{1}{4}r$.

We can show that (5) is the equation of the hypocycloid as follows:

In the general equation for cycloidal curves we have

$$\left.\begin{aligned} y&=(r\pm r')\cos.\,\theta+(r\pm r')\cos.\left(\frac{r\pm r'}{r'}\right)\theta \\ x&=(r\pm r')\sin.\,\theta+(r\pm r')\sin.\left(\frac{r\pm r'}{r'}\right)\theta \end{aligned}\right\} \quad (6).$$

* Ibid. Loco citat.—Prichard's Researches, i, p. 142.

If in equation (6) we take the lower sign and make $r'=\frac{r}{4}$, we shall get

$$\left.\begin{aligned} y&=\tfrac{3}{4}r\cos.\theta+\tfrac{3}{4}r\cos.3\theta=r\cos.^3\theta \\ x&=\tfrac{3}{4}r\sin.\theta+\tfrac{3}{4}r\sin.3\theta=r\sin.^3\theta \end{aligned}\right\} \quad (7);$$

hence from (7) $y^{\frac{2}{3}}=r^{\frac{2}{3}}\cos.^2\theta$

$$x^{\frac{2}{3}}=r^{\frac{2}{3}}\sin.^2\theta\ ;$$

consequently by adding, we get $y^{\frac{2}{3}}+x^{\frac{2}{3}}=r^{\frac{2}{3}}$, which is the same as equation (5). Also in Leroy's Descriptive Geometry this is proved to be the equation of the hypocycloid.

If we differentiate equation (7) we shall get

$$\left.\begin{aligned} dy&=-3r\cos.^2\theta\sin.\theta d\theta \\ dx&=+3r\sin.^2\theta\cos.\theta d\theta \end{aligned}\right\} \quad (8);$$

hence $\int(dy^2+dx^2)^{\frac{1}{2}}=3r\int\sin.\theta\cos.\theta d\theta=\frac{3}{2}r\sin.^2\theta=$ length of the curve: taking the integral from $\theta=0$ to $\theta=90°$, it becomes $=\frac{3}{2}r$. From equations (7) and (8) we get

$$\int ydx=3r^2\int\sin.^2\theta\cos.^4\theta d\theta:$$ taking the integral from $\theta=0$ to $\theta=90°$, this becomes $\frac{3\pi r^2}{32}$ for the area of the curve between the axes $xy$.

Cor. 1. Equation (5) shows that our problem includes question 8, No. 11, Leybourn's Math. Repository, which reads as follows: If from one of the angles of a rectangle a perpendicular be drawn to its diagonal, and from their intersection lines be drawn perpendicular to the sides containing the opposite angle, then putting (P, $p$) for the last perpendiculars, and (D) for the diagonal, $P^{\frac{2}{3}}+p^{\frac{2}{3}}=D^{\frac{2}{3}}$.

Cor. 2. Equation (5) is identical with the result obtained for a question I proposed in the Mathematical Miscellany for 1836, in which it was required to find the locus of the points so situated within a right angle, that the straight line whose length is ($r$) and terminates in the sides of the right angle, shall be a minimum for each of the points.

Cor. 3. Equation (5) furnishes a solution to No. 12 of the Cambridge Problems for 1803, which requires the length of the longest ladder that can be slided up a perpendicular wall from a horizontal plane, under an obstacle given in position—$xy$ will be given as co-ordinate of the obstacle, and ($r$) will be the length of the ladder; hence we have $r=(y^{\frac{2}{3}}+x^{\frac{2}{3}})^{\frac{3}{2}}$ the length required.

In Wright's solutions of the Cambridge Problems, this question is erroneously solved; his result will give $r=(y+x)^{2\frac{1}{2}}$.

ART. VII.—*On the North American Species of Isoëtes and Marsilea;* by Prof. A. BRAUN.—Communicated by Dr. G. ENGELMANN.

Dr. A. BRAUN, since last spring Professor of Botany at the University of Freiburg, Germany, has from time to time communicated to me the results of his investigations on the cryptogamous plants of this country. His notes on *Charæ* and *Equiseta* have been published in a former number of this Journal, (January, 1844.) I am now enabled to offer some remarks of his on the above named genera of rhizocarpous plants. Those on *Marsilea* have been furnished in manuscript; the paper on *Isoëtes* was published in the "Flora, oder Bot. Zeitung," No. 12, 1846.—G. E.

The species of *Isoëtes* hitherto discovered in the United States, have been considered identical with the European *I. lacustris*, Linn., especially one found in Pennsylvania. But this, as well as two others obtained from North America, on careful examination prove to be distinct species. The true *I. lacustris*, if any where in North America, must be looked for in the Northern regions.

Within a few years three new species of *Isoëtes* have been discovered by Durieu in Algeria, and were described by Borg under the names of *I. hystrix*, *I. Durieui* and *I. longissima*. My friends Engelmann and Shuttleworth have enabled me to describe three more species, so that the number at present known is nine, or with the two fossil ones, eleven. It is to be expected that this number will be considerably increased by future researches, as the species of *Isoëtes* are easily overlooked by collectors on account of their apparent sterility.

All the species examined by me may be distinguished by the different size and surface of the spores. Other characters are to be found in the shape of the rhizoma, and in the shape and section of the leaves. These last can be well examined only in living plants; the shape of the rhizoma may also be seen in dried, but not in much pressed specimens. Collectors should pay attention to these circumstances.

All the species are very much alike in general habit. Some are found only under water (*I. lacustris*, *I. flaccida*, *I. longissima*); others grow in shallow water, or on wet places which sometimes become quite dry (*I. setacea*, *I. Engelmanni*, *I. riparia*); others again grow on perfectly dry hills (*I. Durieui*, *I. hystrix*). *I. setacea* of the South of Europe is also often found in dry places; near Frejus it forms large patches of a beautiful green color at the foot of walls; and I have cultivated it in flower pots, which were kept moderately moist. I will here take occasion to remind travelers and collectors, who may meet with species of this genus, that all of them are very tenacious of life, much like bulbous

plants, and may in the same manner be obtained for botanical gardens. The specimens of *I. setacea* cultivated by me, had been preserved in an herbarium near two years, when I had the pleasure to see them vegetate, soon after throwing them in water.

I give the characters of both European species, with the American, in order that they may be compared together.

1. ***Isoëtes lacustris***, Linn. Submersed; rhizoma placenta-shaped, depressed, orbicular or irregular; leaves tubular, semicylindrical, above cylindrical, rigid, fragile, dark green; spores large, covered with coarse farinaceous tubercles, irregularly roughened, scarcely reticulated.

2. ***I. Engelmanni***, mihi. Emersed; rhizoma large, similar to the preceding; leaves longer, more slender, soft, light yellowish-green; sheaths elongated (longer than broad); sporangia longer, spores somewhat smaller, coarse, farinaceous, reticulated.

3. ***I. riparia***, Engelm. MSS. Emersed, rhizoma small (orbicular?); leaves slender, soft, yellowish green, sheaths short (broader than long); sporangia smaller, spores as large as in the foregoing one, very neatly and minutely farinaceous and reticulated.

4. ***I. setacea***, Rosc. Emersed; rhizoma subglobose, regularly trilobed; leaves subulate, somewhat triquetrous, soft, yellowish-green; spores as large as in the foregoing ones, minutely farinaceous, not reticulated nor tuberculate.

5. ***I. flaccida***, Shuttlew. Submersed; rhizoma small; leaves very long, slender, flaccid, yellowish-green; spores very small, minutely pulverulent, not reticulated.

The first, *I. lacustris*, has been found only in middle and northern Europe. It is distinguished from all others by its thicker, stiffer, dark green (when dry, blackish green) leaves, and large spores, which are covered with an irregular granulation. The rhizoma sometimes measures one inch in diameter. The leaves are mostly straight, and 6 to 8 inches long; a variety with shorter leaves (2 to 3 inches long) which are recurved at the tip rarely occurs, probably in shallow water, as the leaves never rise above the surface.

*I. Engelmanni* has been distributed by Dr. E. to many correspondents as *I. lacustris* var. *microspora*. It was afterwards distinguished by him as a species, and named *I. microspora;* but as this name is not sufficiently characteristic, the spores being not much smaller than those of *I. lacustris*, and other species having much minuter ones, I have taken the liberty to give it the name of its discoverer. While *I. lacustris* inhabits, at least in the centre of Europe, only the bottom of cold mountain lakes, mostly with the rare *Nuphar Spennerianum* and *Sparganium affine*, this species grows on the margin of shallow ponds in the

hilly country southwest of St. Louis,* in the warm climate of Missouri, with *Cephalanthus*, *Lycopus angustifolius*, several *Cuscutæ*, *Sagittariæ*, *Polygona*, *Leersiæ*, etc. In winter and spring it is covered by water, but late in summer and in the fall the ground on which it grows is mostly dry, or nearly so. It forms thick tufts with many leaves, 9 to 12 inches long, of a bright yellowish green color. The rhizoma is also flat, depressed, and often one inch in diameter. The sheath or dilated base of the leaf, which bears the sporangia, is longer, and the sporangia themselves somewhat larger, than in any of the other species.

*I. riparia* has been described from specimens collected by Dr. Wm. Zantzinger on the banks of the Delaware below Philadelphia. It grows there with *Sagittaria pusilla*, *Eriocaulon flavidulum*, *Crypta minima*, *Limosella subulata*, etc., abounding among loose gravel and mud between high and low water mark, therefore frequently exposed to the air, and in dry soil. The specimens examined by me are small; the rhizoma hardly 4 or 5 lines in diameter; the leaves 4 to 6 inches long, narrower and more slender than in *I. lacustris*, only 10 or 12 in number, while *I. Engelmanni* has often 30 to 40 or more. Their base is shorter than in either of the preceding, and the sporangia only half as large as in the last. I have not been able to obtain for examination specimens of the *Isoëtes* found in Pennsylvania, on "ponds and shaded wet places," mentioned by Darlington in his Flora Cestrica, nor any from New York, etc., and it is not known whether they are identical with *I. riparia* or not.

*I. setacea* is common in the south of Europe (especially the south of France and Sardinia) and also in northern Africa, and is sufficiently well known. The tufts are always smaller than those of *I. lacustris* and *I. Engelmanni*, but larger than in *I. riparia;* the leaves are still more narrow and slender than in the last species, and 8 to 12 inches long.

*I. flaccida* was discovered by Mr. Rugel in Lake Tamonia, Florida, and first distinguished and named by R. J. Shuttleworth, Esq. It has a small roundish rhizoma, and leaves 18 to 24 inches long, as slender as in *I. setacea*, but of thinner texture, and somewhat transparent. The sporangia are smaller, and the spores by far the smallest of all the species. I am not now prepared to decide, what relation this species bears to *I. longissima*, Bory, from Lake Houbeira, in Algeria, or to an *Isoëtes* from California, which Prof. Kunze considers as identical with *I. longissima*, but which more probably stands near the Florida species, or is identical with it.

* The places where it has been collected by me as late as 1842, are now changed by cultivation, or the vegetation destroyed by hogs and ducks. I have not been able to find it since, but doubt not that it still inhabits more secluded ponds in this remarkable region, where the strata of the carboniferous or mountain limestone offer in their numberless "*sink-holes*" (originating undoubtedly from the caving in of the roof of caverns, and peculiar, in this neighborhood at least, to this formation) many localities of a similar description.—G. E.

## *Marsileæ of North America.*

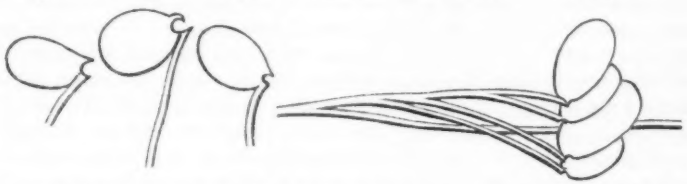
The North American *Marsileæ* form a peculiar group, well distinguished from the species of the old world by the large purple stomata of the capsule, which is always solitary at the base of the petiole, and by the two large conspicuous approximate teeth of the raphe.

*Marsilea uncinata*, A. Braun. (Fig. 1.) Fruit basilar and single; stipe erect, nearly twice the length of the capsule; capsule horizontal, short oval or suborbicular, considerably compressed, truncate behind with a long raphe which terminates in two approximate teeth, the upper one being the longest and uncinately recurved; stomata of the capsule large, purple; paleæ appressed; 13 to 14 sori on each side in the capsule; leaflets narrow at base, fan-shaped, entire, nearly naked.

*Marsilea mucronata*, A. Braun, MSS. (Fig. 2.) Fruit basilar and single; stipe ascending, hardly as long as the capsule; capsule nearly horizontal or slightly ascending, somewhat obliquely oval, slightly compressed, rounded above, carinate below, truncate behind, with a shorter raphe, which terminates in two approximate teeth, the upper one being the longest and straight or slightly curved at the point; stomata of the capsule large and purple; paleæ appressed, indistinct; 8 to 9 sori on each side of the capsule; leaflets spathulate, entire, slightly hairy.

*Marsilea vestita*, Hook. and Grev. (Fig. 3.) Fruit basilar and single; stipe erect, hardly as long as the capsule; capsule ascending, oval, somewhat compressed, with a short raphe which terminates in two approximate teeth, the lower one being short and blunt, the upper one acute, a little larger, hardly curved; paleæ long, dense and somewhat patulous; 7 to 8 sori on each side in the capsule; leaflets entire, covered with paleaceous hairs. (Stomata of the capsule not seen in the young specimen examined by me, but undoubtedly similar to those of the other two species, only more hidden by the paleæ.)

Fig. 2. Fig. 1. Fig. 3. (Half the natural size.) Fig. 4.



This last species was the first of the genus discovered in North America. It was collected by Douglas on the Columbia river, in Oregon, and was described and figured by Hooker and Greville. (*Icones Filicum*, *tab.* 159.) The plant is small, petioles 3 to 4 inches long, and, like the fruit and to some extent also the leaves,

densely coated with long hairlike paleæ. The description of Hooker and Greville, mentions only one tooth on the fruit, but their figure shows both.

*Marsilea mucronata* is nearly related to the Oregon species, but is sufficiently distinguished by the nakedness of the whole plant, and especially by the shape of the capsule. The rhizoma is elongated, and has not the fascicled branches of the following; the petioles are 2 to 3 inches long; and the spathulate or slightly fanshaped leaflets are 3 to 4 lines long. It was collected by Mr. Charles Geyer, in Nicollet's Northwestern expedition, July 24th, 1839, in small exsiccated swamps near Devil's Lake, in the Sioux territory, between the Mississippi and Missouri rivers. It is mentioned by Prof. Torrey in the Catalogue of Nicollet's collections (appendix, p. 165) as *M. vestita*. In several European herbaria it is preserved under the name "*M. quadrifolia*, Herb. Ward;" from where derived is to me unknown.

*M. uncinata* was discovered by Dr. Engelmann, in July, 1835, on the margin of small swamps in the deep bottom woods on the Arkansas river, not far below Little Rock, with *Azolla caroliniana*, etc., and was first described in "Flora, or Botanische Zeitung," 1839, i, p. 300. It is a much larger plant than either of the others, nearly naked, with long petioles, (5 to 9 inches,) and fanshaped leaflets 6 to 10 lines long; the rhizoma produces many fascicled branchlets which are paleaceous at tip. The shape of the capsule and the large number of *sori* in it, readily distinguish it from the others.—A. Br.

*Note.*—I find a fourth species in the collections made by Mr. Lindheimer in Texas. (Fig. 4.) He met with it in January, 1845, in swampy soil on the lower Guadaloupe river, near its mouth in the Matagorda Bay. It is widely distinct from the three others, in having long and branching stipes (10 to 14 lines long) bearing 3 to 5 capsules, three or four times as long as these, and at the base connected with the petiole; capsule obliquely obovate, with a short raphe, lower tooth blunt, upper one very indistinct; stomata not observed on the paleaceous capsule; rhizoma nearly naked, only the ends of the branches paleaceous; petioles 4 to 9 inches long, hairy; leaflets triangular or fanshaped, entire, more or less covered by fine paleaceous hairs, 7 to 12 lines long. It is not improbable that this is the *Marsilea polycarpa*, Hook. and Grev., found throughout South America, and lately discovered by Dr. Schiede in Mexico; but having seen no description of it, I am unable to give more than this suggestion, based merely on the name. If on further comparison the Texan species should prove to be distinct, the name of *M. macropoda* would appear to be most appropriate. Sterile specimens of a *Marsilea* occurring in Drummond's Texan collections, belong probably to the same species as Lindheimer's plant.—G. E.

## Art. VIII.—*Review of the New York Geological Reports.*

(Continued from Vol. i, Second Series, p. 70.)

The members of the New York System which have so far claimed our attention, comprise the whole of the lower and middle divisions. It remains now to pass in review the leading facts bearing on those formations embraced in the upper, last or Erie division. They are exposed chiefly in the middle, southern, and western parts of the state, and, therefore, have been made known to us chiefly by the explorations of the geologists of the third and fourth districts.

In place of the conspicuous calcareous beds of the previous division, we find henceforth schistose, argillaceous deposits, and grits, with only an occasional inter-lamination of subordinate calcareous layers. This change of lithological character is accompanied, as we might expect, by a corresponding variation of organic forms, inasmuch as the nature of the marine sediment necessarily imparts a peculiar type to the inhabitants of adjacent seas. The base of this third division of American Protozoic rocks is formed by the so-called

*Marcellus Shale.* (Lower part of F. 8 of Pennsylvania and Virginia Post-medidial Older Black Slate of Rogers.)—From the Corniferous and Seneca limestones, the last members of the middle division, to this black slate, the passage is abrupt and striking; it affords, therefore, over a very extended district, an excellent guide to the geologist contrasting formations of distant regions.

The lower portion is, like the Utica slate, black and bituminous; in many places so much so that it flames in the fire; hence, as before remarked, it has frequently been mistaken for coal shale, and all along its outcrop, excavations and borings have been undertaken in the hopes of discovering valuable beds of bituminous coal. But, since it is a member of a system of rocks in which no perfect seams of that combustible have ever been found, and belongs to an epoch far antecedent to the true coal formation, these explorations have been equally abortive with those attempted in the region of the Utica slate. The lower division of the Marcellus shale is moreover distinguished by being occasionally calcareous, and is always marked, according to Hall, by one or more courses of concretions or septaria often of a large size. A band of limestone marks their termination as well as the blackest and most bituminous beds. This is overlaid by fissile shales passing gradually from black to olive, which constitute the upper division of the group.

It is inferred, both from the extremely fine sediment of which the Marcellus shale is composed and the preservation of some of

the most delicate structures of its fossils, that it was accumulated during a period of great tranquillity.

By reason of its soft and destructible nature, this black slate is seldom exposed to view, except in ravines and water-courses: nevertheless it has a wide range; commencing near the Hudson river it runs nearly due west to Lake Erie and the west line of the state. This rock and the Genesee slate have doubtless formed the impervious beds which hold up the waters, not only of that lake, but also of Lakes Huron and Michigan, since they show themselves in many places bordering their shores. All that flat wet region of country interspersed with small lakes and ponds, lying in the vicinity of the Kankakee and the head waters of the Wabash, is also probably underlaid either by these schistose argillaceous beds themselves or the clay derived from their disintegration.

In the western part of New York the Marcellus shale is not over fifty feet thick: it thickens, however, to the eastward; we are informed by Vanuxem that in his district it has been bored through a hundred feet in search of coal.

The best localities cited for examining this deposit, are, the ravine of Conesus outlet, west of the village of Avon; the bed and bank of Allen creek near LeRoy; Cherry Valley above the falls of Oneida creek; between Onondaga and Marcellus and the outlet of Owasco lake at Auburn.

Sulphuret of iron occurs every where in connection with this formation; and sulphate of barytes is not uncommon in the septaria. It contains no where valuable minerals. Owing to the presence of sulphuret of iron, the springs issuing from the black slate are often sulphuretted.

By its decomposition a stiff, cold, clayey soil results; but fortunately in the state of New York it is mostly so covered with drift that it rarely gives character to the surface soil to any considerable extent.

Fossils are not abundant in the Marcellus shales. Goneatites measuring sometimes one foot across, occur in the two upper limestone layers between the lower and upper shales.

The forms figured in Vanuxem's Report are given on the opposite page.

The most characteristic fossils of this formation in the western part of the state are embraced in the following wood cut taken from Hall's Report.

The black slate of the Western states has usually been considered the equivalent of the Marcellus shale; but so few fossils have hitherto been observed in that formation in Ohio, Indiana, Illinois, or Kentucky, and these are so obscure, that no satisfactory palæontological evidence has been adduced in support of this decision. Indeed some facts rather favor the idea of its being the

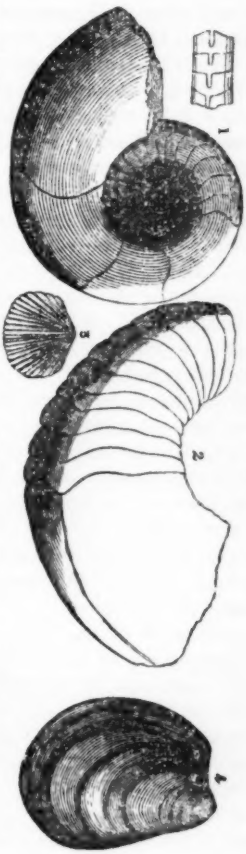



Fig. 1. *Goniatites expansus.* 2. *G. marcellensis.* 3. *Orthis limitaris.* 4. *Cypricardites marcellensis.*

Fig. 1. *Orthoceras subulatum.* 2. *Strophomena setigera.* 3. *S. mucronata.* 4. *S. pustuloet.* 5. *Avicula muricata.* 6. *A. lævis.* 7. *A. equilatera.* 8. *Orthis nucleus.* 9. *Orbicula minuta.* 10. *Tentaculites fisgurella.* 11. *Atrypa limitaris.*

representative of the Genesee slate. Our remarks on this subject will be more appropriately introduced after treating of the succeeding formation, denominated the

*Hamilton Group.* (Part of F. 8 of Penn. and Virg.)—We are informed by Hall, that the line of separation between this and the upper olive shales of the Marcellus group is no where well marked, the change in lithological character being gradual, and even some of the fossils are continued from one into the other, so that the beds last described might be considered the inferior

members, and those now under consideration, the upper beds of one and the same group; indeed in Pennsylvania and Virginia all are included in Formation 8. The New York geologists have separated them only because some of the fossils are peculiar to the Marcellus shales, and some to the Hamilton beds.

The various members embraced in the latter division, are:— Pyritiferous rock and third graywacke of Eaton; Ludlowville, Moscow, and Skaneateles shales; dark slaty fossiliferous shales; compact calcareous blue shale; olive shales, shales near Apulia and Sherburne; Cazenovia group, Encrinital limestone. Under these names have they been noticed in the Annual Reports.

Dull, olive, bluish-gray, calcareous shale constitutes the principle mass. The mud from which it has been derived must have been equally fine with that of the previous group, indicating a continuation of the tranquil condition of the oceanic currents. Towards the east the upper part is more arenaceous, even a regular sandstone.

The range, extent, and bearings are south and nearly parallel with the preceding strata; indeed on the marl the same light blue tint designates all, from the base of the Marcellus shale to the Portage group, and embraces a belt of country from five to ten miles wide running nearly east and west through the middle of the state.

The Hamilton group is of great thickness. Vanuxem informs us that in no part is it less than three hundred feet, and it swells in some places to seven hundred feet; and Hall estimates it on the eastern limit of his district at not less than one thousand feet.

The town of Hamilton, in Madison county, gives name to the group, and it is one of the best localities for examining its most important members. The bank of Cayuga and Seneca lakes, the ravines on the Genesee river near Avon, York, and Leicester, the shores of Lake Erie at Eighteen-mile creek; the hills on both sides of Cherry Valley, Middlefield, Milford, Otsego, Brookfield, Cazenovia, Lafayette, Pompey, Owasco, are enumerated by Vanuxem and Hall as points where its various members can be advantageously studied.

Septaria of very curious and fantastic shapes are of frequent occurrence; so wonderfully regular are some of them that they are usually taken for petrified turtles. The nucleus is either a fossil body or a nodule of iron pyrites around which the segregration has taken place.

Speaking of the general character of the fossils of the Hamilton group, Hall has the following paragraph:—

"Organic remains abound throughout the group, but they vary somewhat in different parts. In the lower division, the most abundant are those of *Orthis*, *Atrypa* and *Strophomena* with some spiral univalves; while above this portion, great numbers

of *Avicula*, *Cypricardia*, *Nucula*, and other similar forms abound, with fewer of genera *Orthis*, *Delthyris*, &c. In the next division *Delthyris*, *Strophomena*, and *Atrypa* abound, to the almost entire exclusion of the forms before mentioned. In the same situations with these we find numerous species of corals: *Cyathophylli*, *Favosites*, and other forms, are abundant; while fragments of crinoidal columns are every where scattered through the mass, or spread evenly over the surface, and form thin layers by themselves."

"The contrast in the prevailing fossils of this group with those of the last is as great as in the lithological products of the two formations. We sometimes indeed meet with a species that occurs in the limestone below, but except in a few instances these recognitions are rare. Some of the more abundant corals are identical, but the great number of new forms renders them of less importance, and in all instances they are too few in number to produce any doubt or difficulty in identification of strata."

"Shells both of the Brachiopoda and Dimyaria have immensely increased, and in many single localities from twenty to fifty species may be obtained."

In Vanuxem's district, where the lithological character of the Hamilton group is more arenaceous, the following are the prevailing forms, as given by that author.

Vanuxem's Report. (36.)

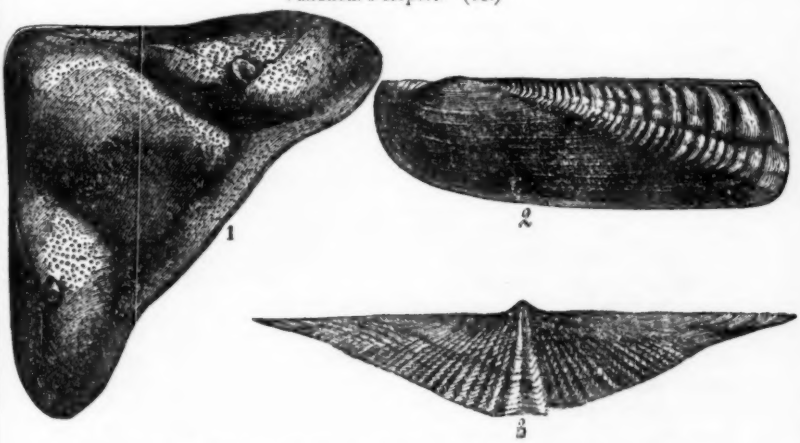



Fig. 1. Head of *Dipleura DeKayi*. 2. *Orthonota undulata*. 3. *Delthyris mucronata*.

Fig. 1 resembles somewhat the head of the Clinton and Niagara *Trimerus*, but differs, according to Vanuxem, not only in the form of the snout, but also in the parts around the eyes being more full and protuberant in the *Dipleura*. It is also allied to the *Homalonotus* of the Ludlow formation of England, but differs in the tail, which, in the *Dipleura*, is divided into three lobes as in the *Trimerus*.

Those on the following plate have been selected by Vanuxem both as common and exclusive species of the group.

Vanuxem's Report. (37.)

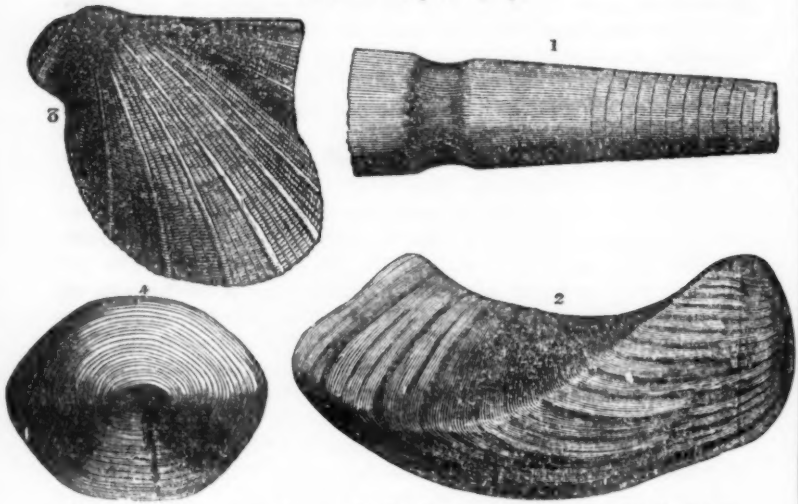
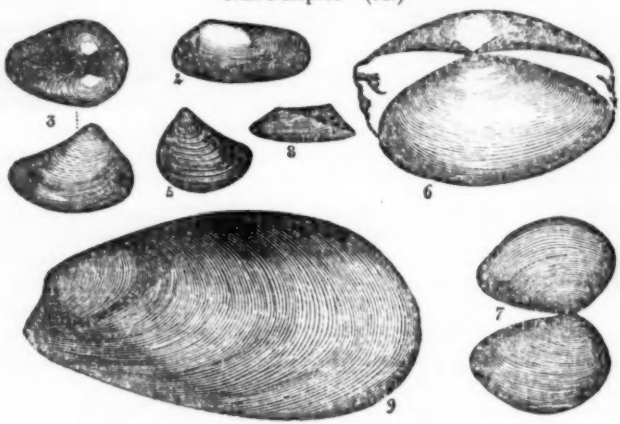



Fig. 1. *Orthocera constrictum.* 2. *Cypricardites recurva.* 3. *Avicula flabella.* 4. *Orbicula grandis.*

The following are given by Hall as the prevailing forms in different parts of the group.

Hall's Report. (78.)




*Bellerophon patulus. Microdon bellastriata.* 3. *Cucullea opima.* 4. *Nucula oblonga.* 5. *N. lineata.* 6. *Tellina? ovata.* 7. *Nucula bellatula.* 8. *Cypricardia truncata.* 9. *Modiola concentrica.*

The whole of the above seem to be American species excepting fig. 5, which is believed to be identical with a species figured by Phillips. Fig. 9, *Modiola concentrica* is thought to resemble in some respects *Modiola (?) semi-sulcata* which occurs in the lower Ludlow rocks of the Silurian system. (See Silurian Researches, pl. 8, fig. 6.)

Hall's Report. (79.)

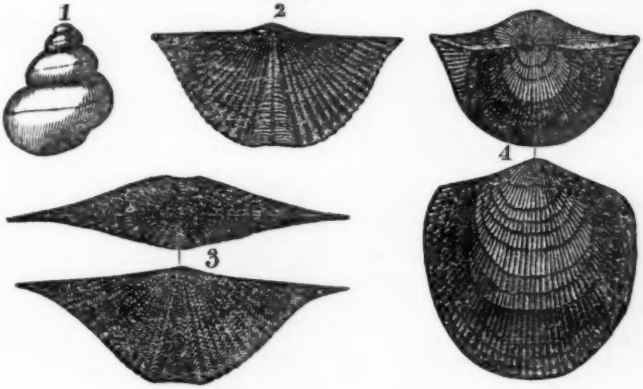



Fig. 1. *Turbo lineatus.* 2 and 3. *Delthyris mucronata.* 4. *Atrypa prisca.*

A few of these fossils are identical with western species. The *Atrypa prisca*, as already remarked, is abundant in the water limestone and shale beds below the black slate, but we have not observed it either *in* or *above* that formation. At the Button-mould Knob south of Louisville, a fossil very like fig. 2, *D. mucronata*, is found, except that those specimens which have come under our observation are not so pointed at the termination of the hinge line, but it would appear that this character is not constant in the same species in the east. The figures of this fossil given in Vanuxem's and Hall's Reports are very instructive as illustrating a most important principle, not only in palæontology, but also in natural history generally; and one which is too often overlooked by describers. It is the very diversified form which the same species will assume by modifying circumstances. Any one who looks at fig. 3, p. 61, and fig. 2, above, would feel little hesitation in pronouncing them distinct species, so very different is their general outline. Had there been but a few specimens of each collected, they would, doubtless, have been described under at least two different specific names; and the intermediate forms, perhaps by several more. It is only by the careful examination of a vast number of individuals and thus tracing the various gradations from one extreme to the other, that they have been

ultimately discovered to be one and the same species. A want of a sufficient number of individuals for comparison, and a too hasty and superficial examination of specimens, together with an inordinate ambition to append *nobis* to a nondescript, has created not only a confusion and a multiplicity of synonyms in many branches of science, but it has often extended the number of species far beyond what maturer deliberation would sanction. In studying the fauna of an unexplored region it may be proper and perhaps is advisable to endeavor to discover the minutest

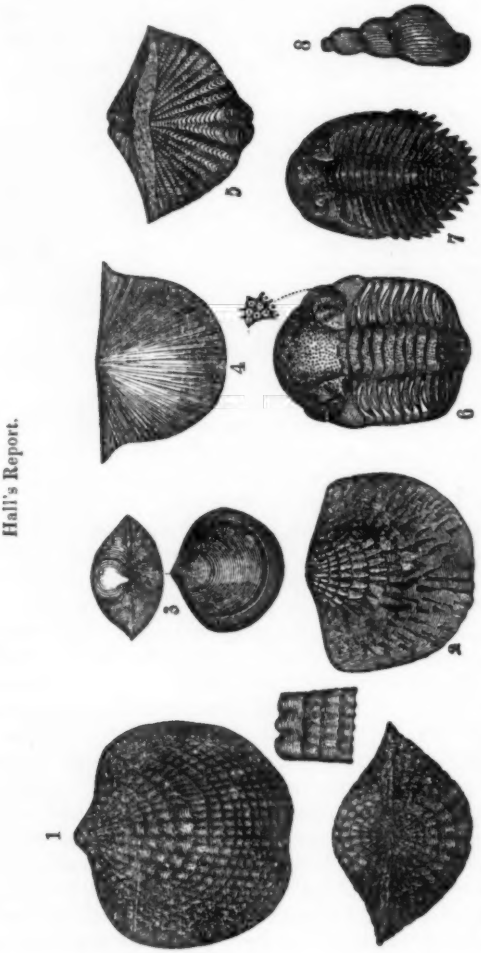



Fig. 1, 2. *Atrypa spinosa.* 3. *A. concinna.* 4. *Strophomena inequistriata.* 5. *Delthyris zigzag.* 6. *Calymene bufo.* 7. *Crypheus callicles.* 8. *Loxonema neritis.*

points of difference, and, if you please for your own convenience and for the sake of classification, to give *provisional* names to those apparently distinct; but we feel convinced that just in proportion as the collection is extensive and the comparison of forms critically traced, the tendency of maturer reflection will be to curtail the number of species. We have been forcibly struck with this fact in our investigations into the specific character of those western palæozoic forms which occur, in certain localities, in such vast profusion.

The diversity of outline which the *D. mucronata* assumes, seems to be caused by a variation in the lithological character of the sedimentary deposits, as appears from the following remarks:—"This very ornamental shell and its numerous varieties in form are very interesting. In the soft calcareous shales of western New York, it is shorter and more rotund; while in the sandy shales and shaly sandstones of the middle and eastern part of the state it is greatly extended and its extremities very acute."

*Calymene bufo*, fig. 6 of the preceding cut, is an abundant and well known fossil of the shale strata on the Falls of the Ohio. It occurs also in the limestone of Red Cedar and the Wapsenonox in the Du Buque district of Iowa.

Hall remarks on fig. 4, *Strophomena inequistriata* of Conrad: "There seems to me good reason for considering this form and *S. mucronata* of Conrad as identical, and that both are identical with *Orthis interstrialis*. (Phil. Palæozoic Fossils, plate 25, fig. 103.)"

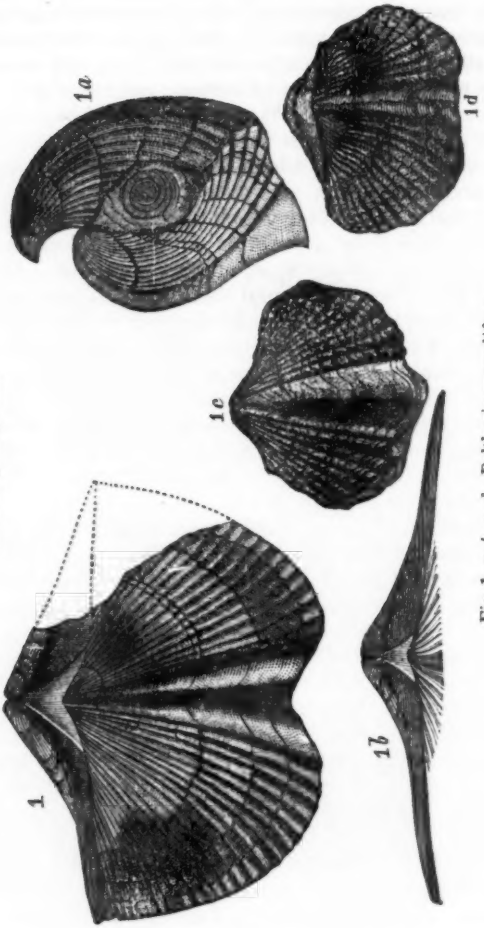
"In the calcareous shales of the Hamilton group, its form is often better defined and more rotund, though the striæ are less sharp; while in the Chemung rocks, it is usually compressed, and very frequently the shell is partially or entirely removed."

Fig. 8, *Loxonema nexilis* is believed to be the same as fig. 183, pl. 38, Phil. Palæozoic Fossils, and *Terebra nexilis* of Sowerby, fig. 17, pl. 54, volume v, Second Series, is given as a synonym.

A thin band of Encrinital limestone below the Moscow shale affords the following fossils: *Avicula orbiculata*, *Atrypa rostrata*, besides three other *Atrypas* and a *Delthyris*. *Avicula decussata* is also associated with the same rock throughout the fourth district.

The species of *Delthyris* considered by Hall as most characteristic, and represented in his Report, are embraced in the two wood-cuts on the following pages.

At Charleston, Clark county, Indiana, an extension of the shell beds of the Falls of the Ohio contains a *Delthyris* having a remarkably broad cardinal area, bearing a strong resemblance to *D. macronota*, fig. 3, of the annexed wood-cut. The aperture of the western fossil is not quite so narrow, the concentric laminæ




Hall's Report, p. 207.

Fig. 1, *a, b, c, d. Delthyris granulifera.*

not quite so numerous, and the beak of the fissured valve does not overhang the cardinal area. These differences are, probably, variations depending on age, geographical distribution and lithological peculiarity, rather than essential specific distinctions.

Both at the Falls of the Ohio and the southern part of the Du Buque district of Iowa, these western rocks contain another Delthyris allied to the above, but, for the most part, having a narrower cardinal area; but a recent inspection of a number of individuals, induces us to believe that this *Delthyris* passes by

almost imperceptible gradations into a species, with a wide cardinal area which cannot be distinguished from *D. macronota.* If we are not mistaken, this is the fossil described by Conrad under the name *D. duplicata.* It is an abundant fossil also in the Louis-

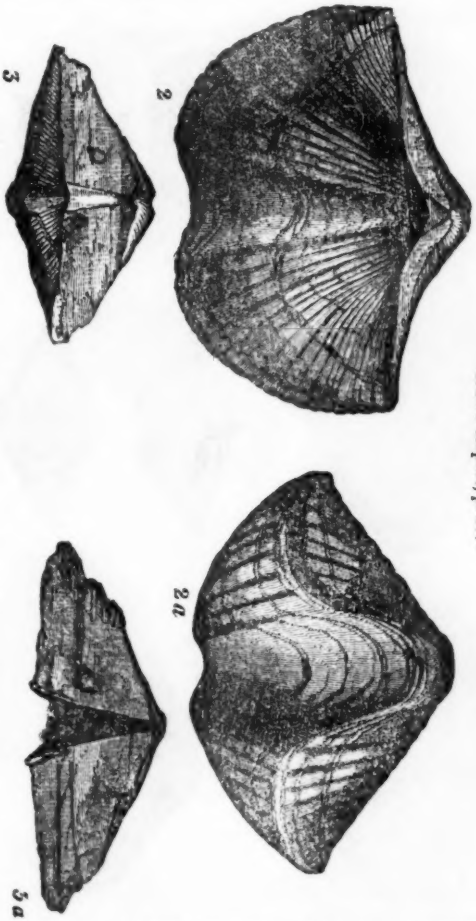
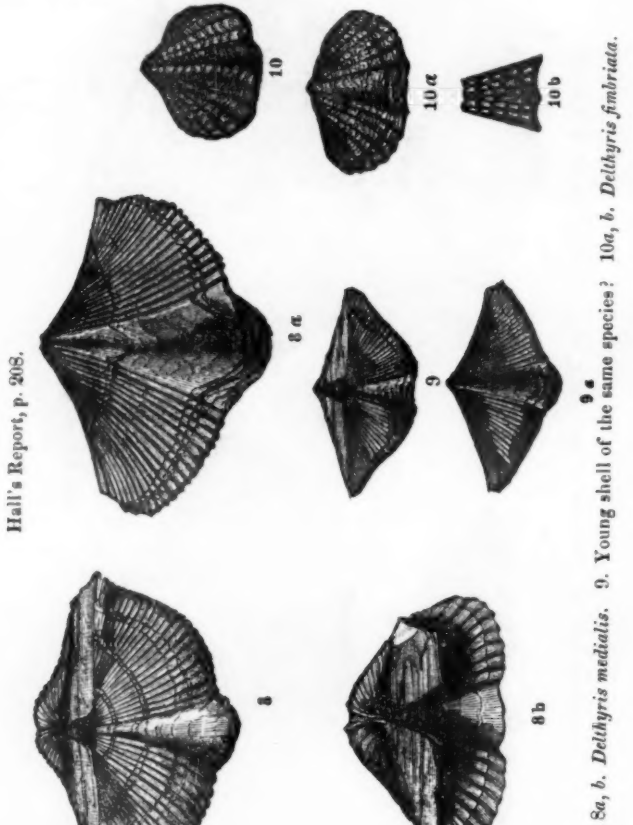



Fig 2. *Delthyris congesta.* 2a. Front view of same. 3. *Delthyris macronota.* Hall's Report, p. 207.

ville water-limestone. We should not be surprised if more extended observation might prove *D. medialis*, fig. 8 of the following wood-cut, to be only a modified form of the same. The number of ribs, and laminæ of growth, and width of cardinal area, are characters which certainly are liable to variation in the same species. Acuteness of the mesial fold, too, depends considerably upon age and condition.

An elegant form of fucoid allied to that characterizing the Caudi-galli grit, appears in this group. It is known as the curtain-shaped fucoid. Here also is the first evidence of terrestrial vegetation. Vanuxem gives the figure of a specimen found in his district, (p. 127,) and another on p. 161; they are not referred to any known plant.




Hall's Report, p. 208.

Fig. 8*a*, *b*. *Delthyris medialis*. 9. Young shell of the same species? 10*a*, *b*. *Delthyris fimbriata*.

Amongst the most numerous corals of the Hamilton group, the following have been selected as presenting some of the most common forms.

The shell and coralline beds of the Falls of the Ohio and its vicinity furnish examples of a coral like fig. 3, though for the most part, in glomerate masses. The fossil to which we have

reference, has been usually regarded as the *Cyathophyllum helianthoides* of Goldfuss, which is also given as a synonym of the New York fossil. Like this Hamilton species the lamellæ of the western coral proceed from the centre, and no transverse laminæ

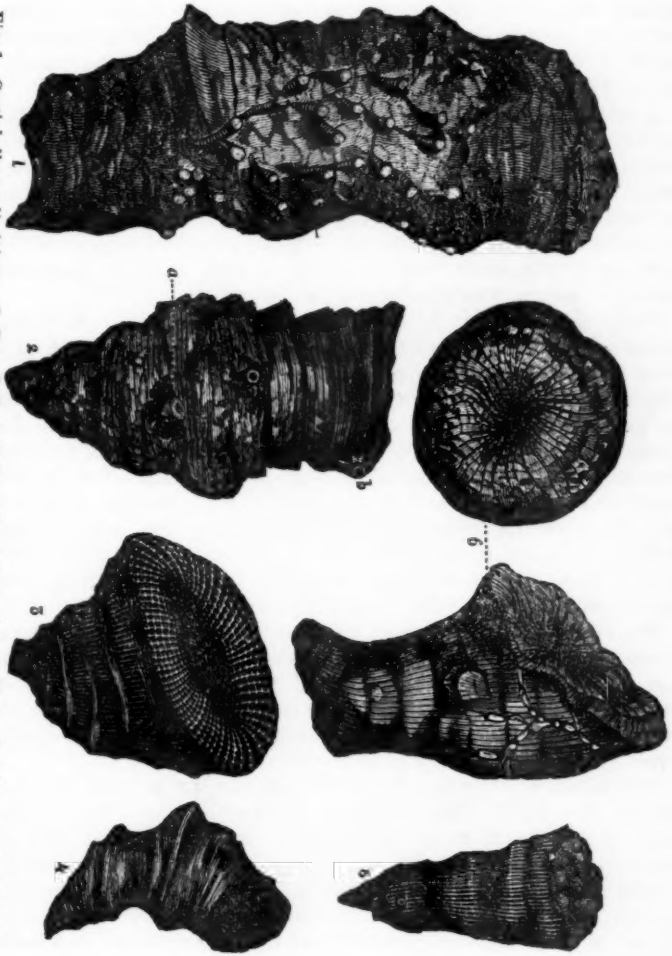



Fig. 1. *Cyatiphyllum cylindricum.* 2. Do. 3. *Strombodes helianthoides.* 4. *S. distortus.* 5. *S.? rectus.* 6. *S. simplex.* Hall's Report, p. 209.

are observable towards the axis, when ground down. The lamellæ do not appear however to be denticulate, but neither the figure nor the description of Goldfuss denote this as a distinctive character of *C. helianthoides.* Following Lonsdale's definition

of *Strombodes*,* Hall supposes this fossil to belong to that genus. If the presence of transverse plates, like the septa of Nautilus, traversing the axis of turbinated corals, is to be regarded as characteristic of a true *Cyathophyllum*, then the coral in question may be entitled to rank as a separate genus, but looking to the original description by Schweigger of *Strombodes*,† we are entirely at a loss to conceive how corals analogous in structure to figs. 3, 4, 5, 6, can be placed in that genus. Here is the translation of Schweigger's description of *Strombodes*.

A calcareous coral stem composed of lamellar, conical cells lying parallel and vertical beside one another, and connected by their expanded margins growing together in the same horizontal plane. A second and third grows up out of the previous one to an equal height with the adjacent ones, their broad margins being in like manner connected together. Thus the coral appears to be made up of a series of connected, *horizontal, vaulted* partitions resting on pillars which permeate the mass.

From the above it is evident that *Strombodes* is essentially composed of *horizontally disposed, vaulted* partitions, whilst these corals consist of *vertical lamellæ*. Now, we would inquire, why should the partial contortion of the vertical lamellæ around the axis of the coral constitute it a *Strombodes?* Turning to the figure of *S. pentagonus*, pl. 21, fig. 2, *a*, *b*, of Goldfuss, and examining the numerous specimens of fossil corals of a similar structure in our possession, we find the vaulted laminæ of which they are made up, to dip into a pillar-like axis, but without the slightest convolution, and even if they did, still no analogy could exist between them and the vertically disposed, partially contorted lamelliferous corals like the figures referred to.

We find it difficult even to admit a generic analogy between *Strombodes* of Schweigger, and Lonsdale's *S. plicatum*, fig. 4, *a*, *b*, *c*, pl. 16, *bis*, (C. plicatum of Gold. fig. 5, pl. 18,) composed of crimped, funnel-shaped laminæ; the more especially if these, as we are led to infer, are spirally contorted around the axis of the coral.

The better to illustrate the above remarks, we subjoin two figures of *Strombodes*, drawn from western specimens in our collection. Fig. 1 seems to be of the same species as Goldfuss's *S. pentagonus*, though the diameter across the margins of the arched partitions is much greater, and their outline more irregularly pentagonal. In fig. 2, which is doubtless a distinct species, the layers are more regularly vaulted and their margins are *confluent*, so that the surface presents small mammillary elevations with depressions in their centers. The upper surface of the arched laminæ is undulating or slightly furrowed. These run in

* Corals composed of "lamellæ contorted spirally."

† See also this Journal, i, ii ser., 185, and this volume, p. 14.

gently curving lines from the axis to the circumference. To the naked eye these appear like striæ or fine vertical lamellæ; no doubt this structure has given origin to the idea that *Strombodes* possessed "lamellæ contorted spirally around the axis." 1*a* shows the disposition of the arched layers dipping concentrically into the axis of growth, and producing, as Schweigger has described, a pillar-like axis permeating the mass.

Fig. 1*a*.



Fig. 1.

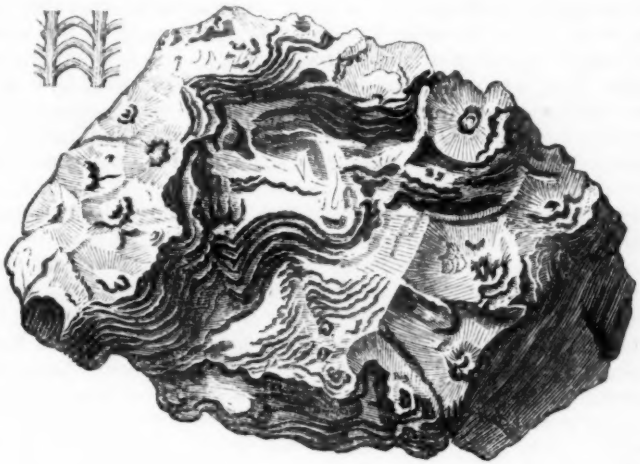
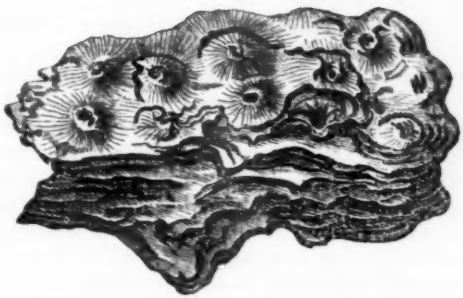


Fig. 2.



*Cystiphyllum cylindricum*, fig. 1. p. 69, is considered identical with a species which occurs in England in the Wenlock formation. It is a remarkable coincidence, that, in both countries, it is encrusted with *Aulopora tubiformis*. The latter coral is found in the west also at Button-mould Knob, near Louisville.

From the preceding comparison of fossils in the east and west, we discover that the rocks immediately below the black slate in the vicinity of the Falls of the Ohio, contain not only Onondaga limestone and corniferous fossils, but likewise some Hamilton fossils. The latter fact rather favors the idea of our black slate being the equivalent of the Genesee slate. The position of our Goneatites rather confirms the same. It is true those found are not identified with New York species; but the first appearance of this family of chambered shells in the west is in an argillaceous limestone, *below* the black slate, whereas in the east they are first observed in the upper limestone layers, separating the lower and upper divisions of the Marcellus shale. So few organic remains have hitherto been discovered in the western black slate that they are but little guide in the solution of the question of equivalency. The *Tentaculites fissurella*, the most abundant of these, occurs both in the Marcellus shale and Genesee slate, and, therefore, does not help us out of the difficulty. A specimen of black slate in our possession, from Jefferson county, Indiana, contains an *Orbicula*, but not in a good state of preservation, so that it is difficult to ascertain its specific characters. The size and outline resemble the *O. lodensis* of the Genesee slate, rather than the *O. minuta* of the Marcellus shale.

On the other hand, we have, both in Tennessee and in Kentucky, (Button-mould Knob,) an encrinital limestone, which may represent the "encrinital limestone of the Hamilton group," since it contains similar entrochites and probably a few other Hamilton fossils. This group is, therefore, but feebly represented in the west, and until we can identify more fossils and establish the true equivalency of the black slate, it becomes difficult to decide what is the representative of the Hamilton group in the west.

In the northwest the limestone of Red Cedar and Wapsinonox is probably its equivalent.*

The fossiliferous shales of the preceding group terminate abruptly, and are succeeded by an impure, dark colored limestone, usually thick-bedded and accretionary especially in its lower part. This rock has derived its name from the village of Tully in Onondaga county, where it is best developed. Sometimes it has thin seams of shale interposed which separate the calcareous part into wedge-form irregular laminæ. This is the most southern belt of limestone in the state of New York. The Tully limestone is of no great thickness, never exceeding twenty feet, even in the eastern extension where it is thickest, and mostly under ten feet. In the western part of the state it is only represented by a calcareous band of three or four inches. It is, therefore, a

* See Report [*Senate*] of a Geological Exploration of part of Iowa, Wisconsin, and Illinois, pages 32 and 33.

very subordinate member of the New York system, and, for this reason, not represented on the chart by a separate color.

Besides the locality already mentioned, the western shores of Lakes Cayuga and Seneca and the outlet of Crooked Lake, the village of Belona, Ontario county, afford opportunity for investigating the characters of the Tully limestone.

No minerals of interest occur in it.

In the fourth district fossils are rare in the Tully limestone, but in Vanuxem's district they are more common. Some of the forms are here given:—

Vanuxem's Report, p. 163.

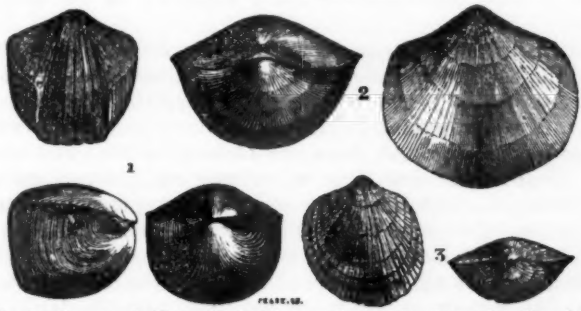



Fig. 1. *Atrypa cuboides.* 2. *Orthis resupinata.* 3. *Atrypa lentiformis.*

Of these, fig. 1, *A. cuboides*, and fig. 2, *A. resupinata*, are peculiar to this rock. Both are English species. The former found in what is considered the Devonian system, the latter in the mountain limestone. Fig. 3 is probably a small variety of *A. affinis*.

Hall's Report, p. 215.
Fig. 4.

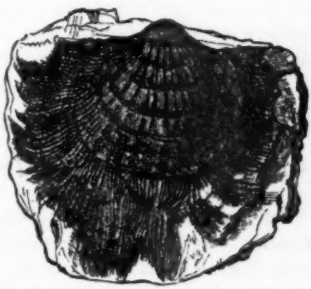


Fig. 4. *Atrypa affinis.*

Speaking of the rocks which follow this formation, Hall makes the following general remarks:—

"In the fourth district, the Tully limestone terminates all those deposits in which calcareous matter forms an essential part. In all the higher rocks, this material, when existing, is the result of the destruction of organic bodies; and in the few instances where it appears the origin is unquestionable, for the fossils still retain so much of their original form as to be readily recognized. This rock forms a strong line of demarcation, not only in this respect, but also as regards fossils; very few forms which are known below continuing into the rocks above. The lithological character

of the products above this rock are throughout more or less similar, while they differ from those below; and, with a single exception, lithological character is a sufficient guide for distinguishing the different strata."

"This contrast of character is more marked towards the western extremity of the district than it is farther east; and, finally, on its eastern extreme, there is a great similarity in the lithological features. This change is likewise attended with the occurrence of some of the fossils of the lower group in the rocks of the higher, the nature of the two being very similar, although the Tully limestone is in its greatest force; while at the west, where it does not exist, no such mingling of the fossils is known."

"At Ithaca, for example, where we are far above the Tully limestone, and where the rocks are well marked by an abundance of fossils peculiar to themselves, still we find the *Microdon bellastriata*, *Modiola concentrica* and some others, and I have detected the *Calymene bufo* and *Dipleura Dekayi* in the same association. Still farther east there is a greater mingling of species of the lower rocks with the upper, and a nearer approach constantly in materials of composition. These circumstances, in the eastern portion of the state, render it difficult to point out the line of demarcation between the lower and higher rocks of this division."

"At the eastern extremity of the state, also, the Tully limestone does not exist, and, therefore, that guide to the line of division between the lower and higher groups is wanting. The absence of this rock, and the similarity of lithological products, as well as the mingling of organic remains of the lower rocks, renders it impossible to make a distinction in groups with the same degree of satisfaction as further west." D. D. O.

(*To be continued.*)

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ART. IX.—*Notice of New Fossil Footprints;* by JAMES DEANE.

SEVERAL new species of footprints of birds, and one of quadrupeds, have been discovered at Turner's Falls, during the past year, and like all others obtained at this remarkable locality, they are singularly distinct, and through their configuration, we are enabled to determine the class of animals by which they were made. The impress of the tarsus and phalanges, and of the dermoid and unguinal appendages is true to life, and their perfection supplies us with the means of connecting the extinct with living races of animals.

The new examples, three in number, are very beautiful; the foot is comparatively long and slender, toes slightly diverging, and the stride of great extent, which indicates that the birds were

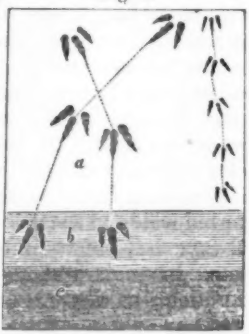
long legged, and also, in connection with the structure of the foot, that they were waders. This was unquestionably the character of the multitudes of birds whose tracks are found in the sandstone of the Connecticut valley. The step is comparatively long in all, and in many very much so. The foot of colossal individuals averages 14 inches in length, and the stride 48 inches in extent, which gives the proportion of 1 to $3\frac{1}{2}$. But in some of the smaller varieties the proportion is vastly greater. Some individuals having a foot of 2 inches, and a stride of 22 inches, or 1 to 11; and the proportion is even sometimes greater than this. The foot of one of the new varieties is 4 inches in length, with a 16 inch stride, or 1 to 4; that of another is 2 inches long, with a 12 inch stride, or 1 to 6. The perfection of the Turner's Falls footprints, not only indicates the order of animals by which they were impressed, but demonstrates the fact, that these early inhabitants of our planet frequented regions which were periodically, or at least occasionally, submerged.

The cause of this submergence, is an enquiry of much interest and uncertainty. From certain facts, it would seem to be due to the action of *floods*, for it is difficult, nay, almost impossible, to see how the exact imprint could be retained, if the overflow were due to the agency of tides. An impression upon soft mud cannot, of course, retain its precise form; a certain degree of hardening, by drying, is necessary to this result, and during an interval of a few hours only this could never happen, unless solar heat were excessive beyond all probability. Many imprints bear evidence that they were made upon soft mud; they are more or less misshapen or obliterated, no trace of articulations, much less of integuments, being perceptible. But one of the most prominent indications that the elevation was due to occasional floods, is the fact, that the *superior* surfaces of the strata upon which distinct impressions occur, are incrusted with a thin glazing, differing in character and often in color from the principal mass. This crust is formed of finely comminuted materials, such as is deposited from turbid water, in a state of comparative rest. This phenomenon may always be observed after summer rains, where water is accumulated in pools and gradually dissipated by evaporation and absorption; or where streams have suddenly overflowed their banks, and have again quietly resumed a former level. A thin, shining, adhesive deposit results, but an interval of several days of summer heat is necessary to harden the surface sufficiently to retain the accurate form of an animal's foot. I have frequently seen upon the same surface of rock several rows of footprints, made by different birds; the impressions made by some individuals were deep and imperfect, having been made while the substance of the rock was yet soft; others were quite superficial, though perfect, being evidently imprinted when the hardening process was car-

ried so far as to offer greater resistance to pressure. I have repeatedly witnessed this process of desiccation upon the alluvial mud of a river's bank, and have removed various footprints of birds, dogs, frogs, &c., which vie with those found in the hidden depths of the rock, and I am satisfied that under existing temperature, even in midsummer, it would be impossible that footprints should retain their perfect configuration, when impressed during the interval between the ebb and flow of tides.

This opinion is sustained by another singular fact. When a stream has a sluggish movement, or where placid water stands at stationary levels, we may observe that at the line of junction with the muddy banks, an abrasion takes place in consequence of the rippling movements of the water. If another depression of level occurs, the wearing process is again repeated, and thus several parallel lines are traced upon the shore, indicating the point at which the water was stationary. Now this phenomenon I have often seen beautifully illustrated upon the rocky strata: for example; I removed from the quarries at Turner's Falls, a large slab of sandstone, the upper limits of which, (a space of six inches in breadth,) was glazed with sedimentary deposit, and was covered with rain-drops and footprints of several varieties of birds. On its lower limits there was an abrasion of the surface, running in a straight line the entire length of the slab, and below this was a second parallel breadth, upon which the surface was still more deeply worn away. The curious fact was illustrated, by finding that the space *a*, above the first line, fig. 1, was completely pitted with hemispherical rain-drops, while not a trace of them occurred below it, that part being occupied by water. The small bird, also, walked directly into the water, but it left no trace below the space *a*. When the waters receded to the second level, the space *b* was exposed, and subsequently the large birds walked directly into the water.—Their imprints upon the space *a*, are quite superficial, but in the space *b*, they are remarkably deep, a condition which proves that the space *a* was hard, while that of *b* was soft, but below this, in the space *c*, not a vestige of any impression is seen, that division being submerged at the time of passage of the birds. Such facts are of frequent occurrence, but it is difficult to reconcile them with the idea that the elevation and depression of the waters is referable to the action of tides. It is proper to observe that the water levels were parallel to the upper edge of the slab, and could be traced a distance of fifteen or twenty feet.

Fig. 1.



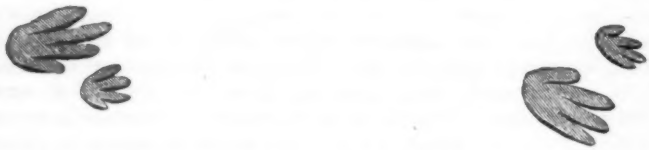
The physical composition of the rock is presumptive evidence that its elements were accumulated in some large basin, through the agency of powerful streams. It is in a great degree composed of the debris of former rocks, of pebbles, great and small, precisely similar to those rounded by diluvial action. Numerous remains of trees are found, both in the stratified and unstratified masses. In fact, it is difficult to avoid the conclusion that these materials were brought down by powerful currents. The limits of the sandstone basin now occupied by the valley of the Connecticut River, are not so extensive as to forbid the idea that an elevation of its waters might have happened from the rising of streams. This would have produced an accumulation of deposits in which remains of the vegetation of the period might be included. Such are some of the considerations which induce the belief that the elevation of the waters of the sandstone basin, and the deposition of sandstone were due to the agency of extensive floods; and we at least know that rains fell abundantly in that remote period of our earth's history.

The new quadruped footprints add a fourth species to the catalogue of this description of fossils derived from Turner's Falls, which locality supplies all that are known in the Connecticut valley. It is probable that they all belong to the Batrachian division of vertebrated animals. The new species was discovered by Mr. Marsh, and is now deposited in his magnificent collection of sandstone fossils. It differs specifically from those hitherto discovered, the footsteps being arranged in two parallel rows, widely separated, whereas, in one of the species, the first and second footsteps fall nearly together, while at the same time there is a remarkable difference in the size of these members. In a second order, the nature of the impressions is so obscure, that the organization of the animal cannot be referred with much probability to any known type. I have elsewhere figured and described these several impressions, excepting the new variety, and only allude to them now for the sake of comparison, and of grouping the whole. With one exception, these quadrupeds moved by walking, although it is probable they were adapted for swimming also. In one instance, however, progressive motion was obviously accomplished by leaping, which, if this conjecture be true, joins the animal to the tailless or ranal family of Batrachians. These animals were all diminutive in comparison with their cotemporaries, the colossal birds, with whom they occupied common ground.

The configuration of the footprints represented by fig. 2, and the relative distance in size between the posterior and anterior feet, assigns the animal, by which they were impressed, to the Salamandrian, or tailed family of Batrachian reptiles. Two species are found in considerable numbers, one having pachydac-

tylous toes, and a short stride, and the other, leptodactylous toes, and comparatively great length of step. Of the stout toed species, there are several grades of size, the posterior foot varying from that of fig. 2, to $2\frac{1}{2}$ inches in length, with a stride of 10 inches.

Fig. 2.



Although the impressions of a single set of feet occur in the anomalous examples, shown by fig. 3, yet I do not doubt but they represent those of a quadruped. I have conjectured that they indicate animals included in the family Rana, and have given

Fig. 3.

a brief notice of them in Vol. xlix, page 80, of this Journal. No additional proofs have been discovered to confirm the opinion heretofore expressed; but to accumulate probabilities, the above sketches of two individuals from distinct strata, accurately reduced from the originals to one sixth the natural size, are added. The general resemblance is seen to be very striking, and it is a curious circumstance, that in each example, A and B, those depressions posterior to the *footprints*, which I have supposed to have been produced by the folded limb of the animal, have the right one projecting farther backward than that of the opposite side. These oblong elliptical impressions are deep at the lower extremity, and gradually become superficial at the other, and the papillose processes of the dermoid covering are apparent. The impressions,

A, are remarkably distinct, showing the articulations of the toes, which is not distinctly the fact in B. Unfortunately, for a clear comprehension of this assemblage of impressions, they have not been found to occur in consecutive series; they are solitary, but this may nevertheless happen from the fact that the animals were able to leap to a considerable distance. Those represented by the diagram, individually occupy a space of 13 by 10 inches, and taking the frog as the representative of the animal, its leaps must have been truly wonderful. The impress of the posterior foot of a frog is nearly as much advanced in position as the former members; they occur upon the outer side, are superficial, and diverge considerably. The impress of the anterior foot is deep and points directly *inward*, while that of the fossil foot is just the reverse, the toes radiating from the tarsus outward. If these views be probable, these impressions constitute the second order of quadruped footprints found at Turner's Falls.

The third embraces those recently discovered, and differs essentially from the foregoing types; the feet are equal, divergent, fall

Fig. 4.

in separate rows, and are planted at regular distances. The impressions are imperfect, but it is probable that each foot comprised five toes, or four toes and a thumb. The specimen contains eight impressions, six of which are represented, reduced to one sixth the natural size. The animal was consequently small. The general aspect of the imprints, namely, the number, divergence and arrangement of the toes, appears to connect this species with the class represented by fig. 2, but they belong to a distinct family; perhaps, however, future discoveries may assign the animal to the order Chelonia. Thus, then, the preceding figures represent the footprints of three distinct orders of quadrupeds. They invariably occur in connection with those of birds.

*Note.*—We add here, for the purpose of calling attention to the subject, a very important observation by Prof. Agassiz, which was communicated to us in conversation, and has been hitherto unnoticed in connection with this subject, that the tracks of birds, when the impression is perfect, may be invariably distinguished by the number of joints of the several toes; the hind toe having uniformly *two* joints, the inner *three*, the middle *four*, the outer *five*.—Eds.

ART. X.—*Notes on the Algæ of the United States;* by J. W. BAILEY, Professor of Chemistry, &c. at the U. S. Military Academy.

SCARCELY any branch of natural history has been so much neglected in the United States as that which relates to the beautiful plants which are referred to the great group of Algæ. With the exception of six or eight species from the neighborhood of New York city, which were sent by Dr. Torrey to the elder Agardh, and which are mentioned in the *Systema Algarum*, I am not aware of any published account of any of the marine Algæ of the United States, prior to the following notice, which I find in the Proceedings of the Boston Society of Natural History, Vol. I, p. 13.

"The President (G. B. Emerson) exhibited (March 17th, 1841) dried specimens of the following marine plants found on our coasts, viz. Fucus vesiculosus; Fucus nodosus; Alaria esculenta; Agarum cribrosum; Laminaria digitata; Desmarestia aculeata; Dichloria viridis; Chorda filum; Asperococcus echinatus; Punctaria latifolia; Delesseria sinuosa; Rhodomenia cristata; Chondrus crispus; Ptilota plumosa; Porphyra several species; Ulva latissima and other species."

I can find no published notice of any of our fluviatile Algæ, although they appear to have been studied with some care by the indefatigable Schweinitz. I have seen in the herbarium of Dr. Torrey, a number of specimens of the fluviatile Confervæ of North Carolina, collected by Schweinitz, and with labels in his own hand-writing, indicating that he considered many of the species as new, and that he had assigned to them names of his own. If he ever published any notice of them, I cannot find it in the books to which I have access.

It appears then, that scarcely more than twenty species of Algæ have hitherto been accredited to our Flora. In this dearth of information, I am induced to hope that the results of my own study in this much neglected but most fascinating department of science, will be received with interest and indulgence.

My attention was first turned to this study at the request of Dr. Torrey, who wished me to prepare a notice of the Algæ of New York, to be included in his Report on the Botany of that State. He kindly placed the whole of his collection of foreign Algæ in my hands, and it is by the study of his authentic specimens received directly from Agardh, Greville, Harvey, Mrs. Griffiths, &c., that I have been enabled to proceed with some confidence in the determination of our own species.

My inland position has, however, prevented me from having many opportunities for collecting our marine Algæ. In fact, with

the exception of two days spent on the sea-shore at Stonington, Conn., in the year 1838, and an excursion with Dr. Torrey for a few hours to the shores of Staten Island, I have had no chance to gratify my desire to study these beautiful productions in their native haunts, until this summer, when in company with Messrs. S. T. Olney, G. B. Thurber, and Geo. Hunt, zealous young botanists from Providence, R. I., I visited various parts of the shores of Rhode Island and Narragansett Bay, and made large collections of the Algæ. A residence of a few weeks at Providence and Newport, also afforded me an opportunity to add much to my collection, and to study microscopically many of the species in their full state of perfection.

It will be seen from the above statements, how slight an exploration has hitherto been made of the Algæ of our shores, and it is hoped that this will serve as sufficient apology for the incompleteness of the list which it is my object now to present.

I have included in the following list every species now positively known to me as growing in the United States, together with a few other North American species. Where no other authority is given, it will be understood that the plant was found by myself growing at the locality mentioned. Where the name of the collector is given followed by a (!), it is meant that authentic specimens from his locality have been examined by myself.

In the classification and names of most of the species, I have followed the excellent Manual of British Algæ, by the Hon. W. H. Harvey, and I must refer to that work for the synonyms of the marine species. Some of the freshwater genera and species are adopted from Ralf's papers in the Annals and Magazine of Natural History, or from Hassall's British Freshwater Algæ. For some of these, synonyms are given.

The principal localities will be referred to by the following abbreviations, viz. *Newport, R. I.* = the rocky sea-shore extending south from the bathing beach at Newport;* *Narr. Pier* =

* Those who feel desirous to visit Neptune's flower-gardens, and "where the sea casts up its briny ooze, to seek for weeds," will find the whole shore at the foot of the cliffs near the bathing grounds at Newport, well worthy of a visit. I presume that almost every marine species mentioned in my list and doubtless many others, may be found there, and I fully believe that Newport is yet to rival Torquay in England, as a locality for fine Algæ. My favorite spots along the shore, are in the small coves about half a mile below "the Stairs," where at low tide it is easy to get out upon

> —— "the rocks where the sea-plants lift
> Their boughs when the tides and billows flow,"

and where

> —— "with its waving blade of green,
> The sea-flag streams through the silent water,
> And the crimson leaf of the dulse is seen
> To blush like a banner bathed in slaughter."

The shores in this neighborhood are covered at low tide with vast quantities of rejectamenta, among which many of the most beautiful of the Algæ may be found;

the pier near Wakefield, R. I., on the west side of Narragansett Bay; *Seaconnet* = shores of Seaconnet Point, R. I., from the pier eastwardly for about two miles; *Ston. Ct.* = Stonington, Conn.; *Prov. R. I.* = Providence, R. I.; *Stat. I.* = Staten Island, N. Y., and *W. Pt.* = West Point, N. Y., and its vicinity for five miles around.

### Series I. Melanospermeæ.

*Sargassum vulgare*, Ag. Seaconnet, Bristol Ferry, and Stone Bridge in Rhode Island. Specimens of this were found by Mr. Thurber and myself growing, *attached to stones*, below low water mark at Seaconnet Point, R. I. I afterwards found fine specimens at the other localities above mentioned. Harvey remarks, that it is "a native of the tropics," and only occasionally drifted to the shores of England; hence the discovery of it, growing attached to rocks on the coast of Rhode Island is one of considerable interest.

*Sargassum bacciferum*, Ag. *Gulf weed.* Floating in the Gulf Stream. My specimens were collected by Lieut. Knowlton, U. S. Army.

*Halidrys siliquosa*, Lyngb. Newfoundland. Edinburgh Encyclop. Fuci, p. 484.

*Cystoseira ericoides*, Ag. Nootka Sound. Dr. Scouler; v. sp. in herb. Tor.

*Fucus vesiculosus*, Linn. } These two species of Fucus grow
*Fucus nodosus*, Linn. } everywhere on our coasts in vast quantities. They are commonly known by the name of *rock weed*, and are extensively employed as manure. It is probable that several other species of Fucus are as common on our coast as they are on the eastern shores of the Atlantic; yet after the most careful search, these were the only species I could detect at Newport, or near New York city.

*Himanthalia lorea*, Lyngb. Massachusetts. G. B. Emerson.

*Alaria esculenta*, Grev. Shores of Newfoundland, M. de Pylaie. Massachusetts, G. B. Emerson.

*Agarum cribrosum.* Massachusetts. G. B. Emerson; Rev. J. L. Russell! Shores near Newburyport, Mass. J. W. Bailey.

*Laminaria digitata*, Lamour. Massachusetts. G. B. Emerson; Narragansett Pier, S. T. Olney!

*Laminaria saccharina*, Lamour. *Ribband weed, sole-leather-kelp, &c.* Very common on the shores of Rhode Island, Massachusetts and Connecticut. Fine specimens are often washed ashore at the bathing beach at Newport.

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but I must caution the fair Algologists who may visit this spot, (some of whom I hope may yet rival in celebrity those distinguished English ladies, Mrs. Griffiths and Miss Hutchins,) that unless they are careful the tide may cut off their retreat from these rock bound bays, and leave them in a predicament from which no Edie Ochiltree could relieve them.

*Desmarestia aculeata*, Lamour. Mass. G. B. Emerson; Nantasket Beach, Rev. J. L. Russel! Newport, not rare.

*Dichloria viridis*, Grev. Mass. G. B. Emerson.

*Padina pavonia*, St. Domingo! It will doubtless be found on our southern coasts.

*Punctaria latifolia*, Grev. Mass. G. B. Emerson.

*Punctaria tenuissima*, Grev. Narragansett Bay, and Newport on leaves of Zostera.

*Asperococcus echinatus*, Grev. Mass. G. B. Emerson.

*Chorda lomentaria*, Grev. Narragansett Pier; Seaconnet and Newport, not rare.

*Chorda filum*, Lamour. Mass. G. B. Emerson. Common on shores of Rhode Island, and at Stonington, Conn., where I saw specimens from thirty to forty feet in length.

*Cladostephus verticillatus*, Lyngb. } Both these species (or as
*Cladostephus spongiosus*, Ag. } I believe *varieties* of the same species) occur abundantly at Newport.

*Sphacelaria cirrhosa*, Ag. Stonington, Conn.; Seaconnet, R. I.

*Ectocarpus siliculosus*. Very common everywhere on our shores, and also in the Hudson River at West Point, sixty miles from the ocean.

*Chordaria flagelliformis*, Ag. Mass. G. B. Emerson. Very common on the shores of Rhode Island and Connecticut.

### Series II. Rhodospermeæ.

*Mesogloia multifida*, Ag. Common, with the preceding plant.

*Halymenia furcellata*, Ag. Newport.

*Polyides rotundus*, Grev. Newport and Seaconnet; Mass. Rev. J. L. Russel!

*Delesseria sinuosa*, Lamour. Mass. G. B. Emerson; Plymouth, Mass. Rev. J. L. Russel; abundant near "the Stairs" at Newport.

*Delesseria Leprieurii*, Montaigne. Shores of Hudson River at West Point, below low water mark. Specimens of this beautiful plant were sent by me to Montaigne, who pronounced them identical with the plant described by him from the coast of Cayenne.* It is *very abundant* at West Point; but I could only find a single specimen of it on the shores of the Hudson at Hoboken, N. J., near the ocean.

*Delesseria americana*, Ag. "Ad litus Americæ Septentrionalis." Ag. Syst. Alg., p. 248. I have not seen any figure or authentic specimen of Agardhs plant; but I suspect it to be the same as a fine species with fronds twelve to eighteen inches long, which grows abundantly near Providence, R. I., in Narragansett Bay. I also found a fragment of the same at Hoboken, N. J.

*Rhodomenia cristata*, Grev. Mass. G. B. Emerson.

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* See Ann. Sci. Nat., 2d Series. Bot. tom. xiii, p. 196, pl. 5.

*Rhodomenia palmata*, Grev. "*Dulse.*" Mass. Rev. J. L. Russell! Common on shores of Rhode Island and Connecticut.

*Plocamium coccineum*, Lyngb. Mass. Rev. J. L. Russell!

*Laurencia dasyphylla?* Lamour. A species of Laurencia occurs abundantly at Newport and at Seaconnet, which appears closely allied to L. dasyphylla, and is perhaps only a variety of that species.

*Chylocladia parvula*, Hook. Common on shores of Rhode Island, from Providence to Newport and Seaconnet. Harvey remarks that he has seen specimens from North America, agreeing in every particular with British ones.

*Gigartina purpurascens*, Lamour. Stonington, Conn., Narragansett Pier, Newport, and Seaconnet.

*Chondrus crispus*, Lyngb. This plant, which is the Carrigeen or Irish moss of the shops, is abundant everywhere on the coasts of New England. At Newport, it is generally known by the name of "Curl" or "Currel."

*Chondrus membranifolius*, Grev. Newport and Narragansett Pier; Mass. Rev. J. L. Russell!

*Sphærococcus multipartitus*, Ag. *δ angustissimus.* New York. Ag. Syst. Alg. p. 216. Shores of Staten Island. Dr. Torrey!

*Sphærococcus Torreyi*, Ag. New York Ag. Syst. Alg. p. 218.

*Ptilota plumosa*, Ag. Mass. G. B. Emerson and Rev. J. L. Russell! Seaconnet, R. I. Particularly abundant and fine near "the Stairs," at Newport.

*Polysiphonia subtilissima*, Montaigne. Hudson River, below low water mark, at West Point, sixty miles from the ocean. Specimens of this have been sent to Montaigne, and he pronounces them identical with those he has described from Cayenne. It is remarkable that it is accompanied, both at West Point and Cayenne, by the *Delesseria Leprieurii*, Mont.*

*Polysiphonia violacea*, Grev. Narragansett Bay, R. I., Staten Island, N. Y. Common.

*Polysiphonia fastigiata*, Grev. Common on Fuci, at Newport and Seaconnet; Plymouth, Mass. Rev. J. L. Russell!

*Polysiphonia stricta β. atropurpurea*, Ag. New York. Ag. Syst. Alg. p. 150.

*Polysiphonia nigrescens*, Grev. Newport.

*Polysiphonia Brodæii*, Grev. Plymouth, Mass. Rev. J. L. Russell! Newport, R. I.

Besides the above, I have two or three species of Polysiphonia from Rhode Island, which I have not yet satisfactorily determined.

*Dasya pedicellata*, Ag. "Ad Noveboracum." Ag. Syst. Alg. p. 211. Very beautiful specimens occur in abundance near Providence, R. I., also at Newport, R. I. I have seen a fragment of

* See Am. Sci. Nat., 2d series, Bot. tom. 13, p. 196, pl. 5.

the same from New Haven, Conn., collected by Professor C. U. Shephard.

*Ceramium rubrum*, Ag. Only *too* common, every where on our coasts.

*Ceramium diaphanum*, Ag. Nearly as common as the preceding.

*Griffithsia* ——? An undetermined species occurs at Providence and Newport.

*Callithamnion Turneri*, Ag. Parasitic on Cladostephus, &c., at Newport.

*Callithamnion Rothii*, Lyngb. On rocks under the Fuci, at Newport.

*Callithamnion* ——? A delicately branched species, which I have been unable to determine, occurs plentifully near the Tockwotton House, at Providence, R. I.

*Trentepohlia pulchella*, Ag. Cascade at West Point; parasitic on *Lemania fluviatilis*.

Series III. CHLOROSPERMEÆ.

*Lemania fluviatilis*, Ag. Cascade at West Point; Mountain Run, Culpepper Co., Va.; and Falls in the Rappahannock River, above Fredericksbnrg, Va.

*Lemania tortulosa*, Ag. Foot of Crow's Nest, West Point; Mass. Rev. J. L. Russell.

*Thorea viridis*, Bory. N. America. Ag. Syst. Alg. p. 56. Agardh suspects it to be an Oscillatoria adhering to some aquatic plant.

*Batrachospermum moniliforme*, Ag. Salem, N. Ca, Schweinitz. Abundant just below the dam of Reservoir Pond, near West Point.

*Batrachospermum Americanum*, Schweinitz. Salem, N. Ca. Schweinitz! Common in small streams near West Point; Hingham, Mass. Rev. J. L. Russell.

*Bulbochæte setigera*, Ag. Common in ponds near West Point, Spectacle Pond, near Providence, R. I., Worden's Pond, R. I.

*Draparnaldia plumosa*, Ag.
*Draparnaldia glomerata*, Ag.
*Draparnaldia tenuis*, Ag.
} These species are all common at West Point, and I have specimens of them also from Massachusetts, sent by Rev. J. L. Russell, and from Chautauque Co., N. Y., sent by M. S. Petit, Esq.

*Chætophora endiviæfolia*, Ag. Mass. Rev. J. L. Russell! Ponds in New York and Rhode Island.

*Coleochæte scutata*, Breb. This most beautiful plant occurs abundantly in Round Pond, near West Point, where I found it in fruit in September. Both varieties, $\alpha$ and $\beta$, of Brebisson, (with every intermediate state,) occur, and *both with fruit*. The fruit of variety $\beta$ is in the form of capsules on the ultimate ramuli, which do not appear to have been noticed by any previous writer.

*(To be continued.)*

ART. XI.—*On the Fossil Vegetation of America;* by J. E. TESCHEMACHER.

ON the 17th June, 1846, I read a paper before the Boston Natural History Society, on the fossil vegetation of America, which will probably be published in the forthcoming number of their Journal, with plates.

I propose the present communication as a continuation of that paper.*

Having recently received, by the liberality of Dr. L. Feuchtwanger, a number of specimens from the coal mines of Carbondale, Pa., I will proceed to describe a portion of them, after offering a few general observations.

The well understood and authenticated alternation of growth in the American forests, of resinous and hard wood trees,† must create surmises as to the probability of the existence of the same law during the growth of the successive forests which formed the successive layers of coal, a large portion of which were certainly of resinous woods. But we find no evidence or appearance of the same alternation taking place with the undergrowths of recent forests, particularly with the Fern and Equisetum tribes. The constituents of the Equisetaceæ are better known than those of the Filices; and silica, the chief inorganic ingredient of the former is usually in such quantity in most soils, particularly in those from the recent disintegration of early crystalline rocks, that it would not be easily exhausted so as to render this alternation of growth necessary.

Sigillariæ, (which I consider as the stems of Filices,) with leaves of Filices, and Calamites, (probably Equisetaceous plants,) are found in all coal deposits hitherto examined; whether the highly resinous tribe exists in all, is yet to be ascertained.

An important source of information is presented by the vegetable remains existing in the coal itself, leaving out of consideration those in the shaly roofs, and clayey floors of the mines. The Pennsylvania anthracites offer many specimens of these; what is termed charcoal is commonly found in seams and crevices in the coal, and in most of this, the vegetable tissues, although carbonized, are in perfect preservation. I have selected some specimens in which the indication of different kinds of wood is very clear;

* Fig. *a*, pl. 4, contained in that communication, is probably a *Brachyphyllum*, (Brongn.) although differing essentially in foliage from any yet figured.

† Alden Bradford, in a paper dated 1793, printed in the Massachusetts Historical Collections, vol. 2, on the topography of Duxbury, Mass., states the timber growing there to be white and pitch pine, maple, ash, beech, oak, walnut, &c., and says that Capt. Samuel Alden, who died there in 1780, aged 93, remembered the first white pine tree that appeared in the town, one eighth of which, in 1793, was covered with them.

amongst them is one Sigillaria of an undescribed species, a few impressions of leaves with forked veins, like *Sphenophyllum*, and several branches and stems unlike any I have seen figured, also groups of vegetable tissue resembling nothing in the present vegetable existences. But I have not had time to bestow on these the study they appear to merit, and merely mention them now to draw towards them the attention of others.

The analyses of these so-called charcoals of various forms, compared with analyses of charcoal artificially prepared from recent resinous and non-resinous woods, and particularly from arborescent ferns, might prove very interesting; indeed, we appear to be only just entering the threshold of the science of fossil vegetation.

From what I have hitherto observed, it seems altogether probable that intense and long continued pressure beneath water, has transformed the ancient forests into coal.

### *Coal Plants from Carbondale, Pa.*

CALAMARIEÆ.

*Calamites Suckowii*, Brongn. The longest diameter of this specimen is 3½ inches; it has been squeezed into a wedge-like form, and striæ caused by the pressure are quite distinct on the thin edge of the wedge on the carbonized surface, indicating the pressure to have taken place subsequent to carbonization. There has also been perpendicular pressure, as the vegetable is bent over at right angles to the upright stem.

*C. ramosus*, Artis and Brongn. A very beautiful and distinct specimen. The nearly circular scar at the articulation of the branches is not so tumid as in the figure given by Brongniart, but the striæ and their terminations are in exact accordance with it.

*Calamiteæ?* gen. and spec.? (fig. 1.) It is doubtful whether this belongs to this division, as in my specimen, which is 6½ inches long and more than 1 inch wide, there is no articulation. The texture appears to have been very thin and delicate, the striæ and the scar of the branch are beautifully distinct, and the opening of the striæ above the scar, and their rejunction below, have not at all the appearance of Calamites.

Fig. 1. (Nat. size.)

*Sphenophyllum Schlotheimii*, Brongn. Enveloped in and surrounded by leaves of this fossil, are very fine and clear impressions of jointed stems, with attached side branches, exactly resembling the figure in Lind. and Hutt., vol. 1, tab. 19, fig. 1, of *Bechera grandis;* it is not possible to doubt that the leaves belonged to these stems and branches.

FILICES.

*Neuropteris*? spec. (fig. 2.) A large species; leaves cordate, with an extraordinary difference in the size of the lobes, the lowest being the largest. My specimen of a frond has 14 leaves, the terminating one acute and one lobed. Many of the leaves resemble those of the recent *Isoloma lanuginosa*, J. Smith, (Lindsea auctor.,) nor does the midrib in some of the leaves of Neuropteris, become indistinct sooner than that in this fern. The club-shaped termination of the veins of Isoloma does not exist in Neuropteris, although I have thought that I could observe a curving of the margin, with a slight appendage, as if it were possible that there might be a resemblance to the marginal fructification of Isoloma.

Fig. 2. (Nat. size.)

*Neuropteris rotundifolia*, Brongn. Specimen clear and distinct.

*Cyclopteris orbicularis*, Brongn. } Specimen
*Adiantites cyclopteris*, Göpp. } fine.
*Sphenopteris latifolia*, Brongn. } My specimens
*Aspidites latifolius*, Göpp. } agree in character and appearance with Brongniart's figures, but not at all with the figures of Lind. and Hutt., of this fossil.

*Pecopteris unita*, Brongn.

*Alethopteris*, Göpp. } ? spec.
*Pecopteris*, Brongn. } Fig. 3.

Fig. 3. (Natural size.)

This specimen bears a greater resemblance to *P. Serlii*, Brongn., than to any other fossil, but the leaves are quite obtuse, or may even be called round. The terminating leaf, as well as some of the others, are lobed, and the veins are quite as perpendicular to the midrib as in *Tæniopteris Betrandi*, Brongn. Hist. Veg. Fos., tab. 82, fig. 5.

SIGILLARIEÆ

*Sigillaria Serlii*, Brongn.
*Saullii*, do.
*Schlotheimii*, do.
*oculata*, do.
*Syringodendron*, Sternb.
*Rhytidolepis*, Cotta.

It seems to me almost impossible not to be convinced, by the arguments of Brongniart, that these are the stems of the abores-

cent ferns, whose leaves are scattered in such profusion around them, although I am aware that both Göppert and Lindley have withheld their full assent to this opinion.

The specimen of *S. oculata* is surrounded by leaves calculated to remove a portion of the doubt on this subject. Fig. 4 is a representation of what I consider the upper and under side of the leaf. On the upper side, *a* and *b*, there is the impression of a fine channel along the midrib, caused by the protuberance of what may be termed the receptacles of the fructification on each side of the midrib on the under side; the depression in the slate, letter *b*, caused by these protuberances, is very clear in the specimen. Fig. *c* represents the under part of the leaf; here the spaces corresponding to these protuberances are pitted, as represented by the dotted part. The space between these dots and the margin of the leaf, is *perfectly smooth and even*, and the separation between them well defined. I consider this pitted part to be the impression of the fructification of a species of Blechnum. In order to make this clear, fig. 5 represents impressions in fine plaster of Paris, of leaves of the recent aborescent fern, *Blechnum braziliense*—*a* the under side, *b* the upper side. It is difficult in figures to give every character of the resemblance, but I am sure it is too perfect to be mistaken.

Fig. 4.

Fig. 5.

The veins in this species of recent Blechnum are internal and not very prominent, and the texture of the leaf is hard and coriaceous; in my first impressions in plaster, the veins were slightly exhibited, and there is no trace of them in the fossil; but on the application of slight pressure to the recent leaves prior to taking off the impressions, it became as smooth as the fossil. It is true that in *B. braziliense*, the sori, though contiguous and confluent, are not single and continuous along each midrib as they appear in the fossil, but in *Salpichlæna volubilis*, (J. Smith,) the *Blechnum volubile* of Kaulfuss, and in others, this continuous linear character exists.

I believe this to be the first fructification of a fossil fern resembling Blechnum that has been observed; I would, therefore, name this Blechnites oculata, but I am in hopes that careful observations of the coal deposits will ere long enable us to assign the foliage belonging to most of the stems, and then a revision of the nomenclature will become necessary.

I regret that in my specimen neither end of a leaf is present; but from the width, both of the leaf and the fructification, it is probable that it was a larger fern than *B. braziliense*.

If the specimen of *Sigillaria lepidodendrifolia* figured by Brongniart, Hist. Veg. Fos., tab. 161, were carefully examined, leaves like the above described would probably be found.

Among these specimens from Carbondale, are impressions of stems without any other marks than striæ of different sizes, and others marked in various ways, with irregular protuberances and indentations. Several of these exactly resemble a stem figured by Göppert, (Syst. Fil. Fos., tab. 39, fig. 1, without remarks,) and the outside bark of one of these being partially removed, exhibits the impression of a beautiful Sigillaria, somewhat like *S. macrodiscus*, Brongn., on a very small and delicate scale.

Of these stems, and many other appearances from the fossil vegetation from this locality, it is quite impossible to give descriptions that would be at all intelligible without very well drawn figures. There are also several probably undescribed Lepidodendra and Sigillariæ.

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ART. XII.—*On the existence of certain Lacustrine Deposits, in the vicinity of the Great Lakes, usually confounded with the "Drift;"* by I. A. LAPHAM.

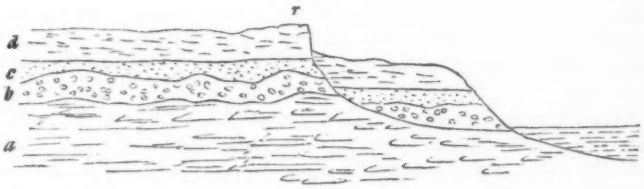
OF all the subjects investigated by the geologist, none are more interesting or have attracted more attention within the last few years, than those relating to the diluvial, or drift and boulder formation; and although much has been done to elucidate this obscure point in the history of the earth, and a vast amount of facts and observations has been collected and recorded, we are still without a satisfactory theory that will explain all the facts. One reason of this may be that no one theory *can* be found sufficient; the subject must be divided, and each portion may admit of a different explanation.

There is no doubt that much of what usually passes for drift in the region of the great lakes, must be attributed to a lacustrine origin of more recent date. These deposits consist of nearly uniform layers of fine clay resting upon irregular beds of sand, gravel, boulders and hard-pan, constituting the true drift. The layers are from a quarter of an inch to three or four inches in thickness, and lie nearly horizontal—not conforming with the irregular layers of drift. The beds sometimes attain a thickness of fifteen or twenty feet. It is evident that these layers were deposited when the water was calm, and not subject to those violent agitations that existed during the deposition of the drift.

An attentive examination of facts connected with the action of the waters of the present lakes, may throw some light upon this interesting subject.

The shore of Lake Michigan near this place, (Milwaukee, Wisconsin,) consists of clay, sand, gravel and boulders, rising almost perpendicularly from fifty to one hundred feet. The several layers are usually arranged as follows:

Fig. 1.




*a*. Hard-pan, or very tough blue clay with imbedded pebbles.
*b*. Irregular beds of gravel, at some places fine, at others coarse, approaching boulders.
*c*. Very fine sand, free from pebbles or clay.
*d*. Fine reddish clay free from sand, pebbles, or boulders, having its base line nearly level.

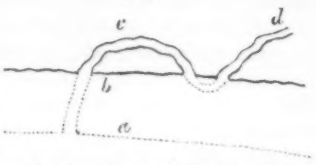
Along the line between *a* and *b*, are numerous springs, usually of pure cold water, but occasionally impregnated with mineral substances. Some hold lime in solution in such quantities, as to cement the beds of gravel into a kind of *pudding-stone*, and incrust the moss, leaves, &c. over which they pass, affording many fine and beautiful specimens. On the canal, half a mile above the city, is a chalybeate spring issuing from a bed of gravel colored with the iron deposited by the water.

Every storm-wind dashes the waves against the base of this steep bank, carrying away the light materials of which it is composed, and causing the higher portions to slide down as represented in figure 1; an operation which is materially assisted by the springs above alluded to. This process is in some places quite rapid, and has been in operation for a great length of time. Many very interesting facts might be mentioned to illustrate this, and a few years of direct observation are sufficient to convince the most skeptical.

A road laid out nine years ago on the bank of the lake, is now so near the margin that it would be impossible for a wagon to pass along it in the tracks then made, without falling down the slope. (See fig. 1, *r*.) Walking along the sandy beach of the lake, we often find the clay has slid down upon it, so that it is necessary to clamber over the avalanche or wade around it in the waters of the lake. These slides, under favorable circumstances, are very extensive, carrying down with them the forest trees without disturbing their erect position. At other times, trees are thrown down towards the bank, presenting their roots to the water. At Southport, thirty-five miles south from Milwaukee,

the bend of a stream has been carried away, so that its valley presents three openings to the lake, as represented in figure 2, where the dotted lines represent the ancient state of things and the black lines the modern. Similar instances may be observed at other places along the shore of the lake.

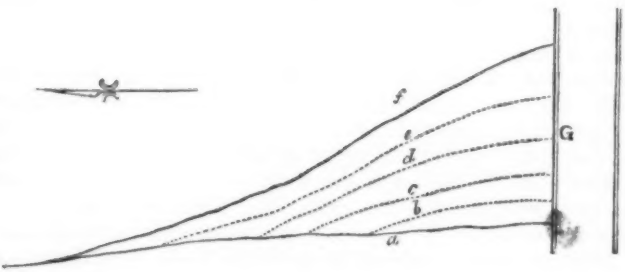
Fig. 2.




*a*. Ancient coast.—*b*. Present coast.—*c*. Bayou.—*d*. River.

The prevailing storm-winds here are from the northeast, striking the coast obliquely and carrying the gravel and sand acted upon by the waves in a southerly direction, or towards the head of the lake. The progress of the pebbles along the shore is slow, each storm carrying them but a small distance; yet the constant action of the waves through a long period of time, has been sufficient to accumulate vast fields of sand around the southern extremity of the lake. When a solid pier is built into the lake, this motion of the sand and pebbles causes a rapid accumulation on the north side of it. At Chicago, during five years, the accumulation of sand extended no less than seven hundred and twenty feet along the pier. As soon as the sand reaches the end of the pier, a bar is formed across the mouth of the harbor, rendering another "appropriation" necessary to extend the pier further into the lake. How far it will be necessary to extend the pier before the difficulty will cease, is not easily determined. It will be when the direction of the shore north of the pier is at right angles with the direction of the prevailing storms. Figure 3 represents the shore at this place in the different years from 1834 to 1839, and is copied from an official report of the Topographical Bureau at Washington. Since 1839, no reports have been made.

Fig. 3.




*a*. The original shore.—*b*. Shore in 1835.—*c*. Shore in 1836.—*d*. Shore in 1837.—*e*. Shore in 1838.—*f*. Shore in 1839.—G. North pier.

The immediate effect of these storms, as above stated, is to carry away the base of the steep bank along the shore, moving the sand and pebbles by successive steps towards the south. But the finer materials—the soft clays—are suspended in the water of the lake, causing it to be muddy for a great distance from the land. The quantity of matter suspended in the water, and the distance it is carried out, will of course vary according to the force and direction of the storm, the configuration of the coast, the material of the bank acted upon, &c. When the storm abates, the agitation of the water ceases, and the suspended matter is thrown down in the form of a thin deposit of mud, on the bottom of the lake. If it falls in water so deep as to be beyond the influence of the surface waves, it must remain as a permanent deposit. Another storm produces another layer, and should it come from a different direction, there may be a slight difference in the nature of the material deposited. By this process, continued through a succession of years, a large amount of fine sediment will be accumulated in the bottom of the lake. The analogy between deposits thus formed and those before mentioned, as found overlying the drift, in many places, cannot be doubted; thus affording one more instance where causes now in operation are found adequate to produce geological phenomena heretofore supposed to originate in convulsions of nature.

It has been shown, by various facts, that these lakes have at former periods occupied much higher levels than at present.—The existence of ancient lake beaches, at various elevations, (sometimes exceeding a hundred feet,) above the present surface, is sufficient proof of this. We may, therefore, expect to find these deposits of fine sedimentary matter at places much above the waters of the lakes, precisely as we now actually find them.

The lake deposits may be distinguished from the true drift by the greater uniformity and regularity of the layers, and the finer and more uniform texture of the material of which they are composed, and the absence of boulders and irregular beds of gravel and sand. They have been observed in places remote from the present lakes, showing that the waters were once even more extensively spread over the country than at present. They exist in greatest force, so far as is known to the writer, around the western extremity of Lake Erie. In passing over the railroad westward from Detroit, no boulders, or other indications of drift, are found on the surface until we pass the ancient lake beach at Ypsilanti, beyond which they begin to appear in great numbers. East of that beach was evidently once the bottom of a lake.

Some of the most interesting deposits of this kind are found within the limits of the city of Milwaukee; and it is from them that the material is taken for the manufacture of the much celebrated cream-colored brick, of this city. Such is the richness

and beauty of these brick, that they are becoming an article of export. Strangers, upon landing here, are surprised that all the brick houses are *painted* of the same color; and their surprise is not abated when informed that they are not painted at all—the color being that of the bricks themselves.*

No fossils of any kind have yet been discovered in these lake deposits. Cylindrical concretions, of an interesting kind, are often found investing the fibres of roots that have penetrated the layers; more commonly the root has decayed, leaving only a small opening through the centre. On breaking across one of these concretions, it is seen to have a concentric structure, as if made of concentric cylinders. Their form is usually cylindrical, tapering at each end. They are much harder than the surrounding mass of clay.

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ART. XIII.—*On the Origin of Continents;* by JAMES D. DANA.

IN a paper on the Volcanoes of the Moon, read before the Association of Geologists and Naturalists, in September last,† some suggestions were thrown out with regard to the Origin of Continents, drawn from the condition of a cooling globe. It was observed that the portions of the earth now constituting the great areas of land, were free, or nearly so, from volcanic action, even in the Silurian period: while the oceans appear to have been regions of eruption. Hence it was inferred that contraction must have taken place to the greatest extent over the parts now oceanic, just as any cooling sphere becomes depressed on the side which cools last. This was shown to correspond with the actual history of our globe, inasmuch as an increasing depth in the ocean cavity would necessarily leave more and more land above water in successive epochs, as accords with observations. It was observed that the hypothesis was *farther* borne out by facts: for while it appears that the land has, on the whole, been increasing in extent, even through the tertiary era and subsequent to it, the ocean's bottom has actually subsided several thousand feet within a late period, as shown by the coral islands scattered over the wide Pacific.‡

* This color is owing to the almost total absence of iron from the clay, and the very small quantity discovered by the usual tests, is sufficient to impart a very delicate cream tint to the bricks.—EDS.

† See this Journal, ii, ii ser., 352.

‡ If we consider that *two hundred islands* have subsided in the Pacific, which, had there been no corals, would have disappeared without a record, we perceive that the comparative absence of islands from the Atlantic, whose waters are, to a large extent, too cold for corals, proves nothing against the hypothesis. On the contrary, so large a bare surface of waters is probable evidence of the disappearance of some points of land by submergence. All existing Atlantic islands are of igneous origin except the Falklands, to the east of Tierra del Fuego.

By reference, therefore, to the principle of unequal contraction, and to those *subordinate* causes of change of level usually appealed to by Geologists, (though treated of commonly as primary in importance,) we may obtain a general view of the origin of the earth's features. I propose at this time to offer a few remarks in illustration of this subject, derived from the features of our own continent, reserving a fuller discussion for another occasion.*

The effects of contraction as a geological cause, though long admitted, have been first brought out in their various bearings by M. Constant Prévost, before the Geological Society of France.† The facts adduced substantiate his views, though, as we believe, with some limitations. They lead us farther to connect the various phenomena, and tell why the ocean and land have their present bounds.

In order to understand the bearing of the facts, we should bring to mind the effects of contraction. The more prominent are as follows:—

1. Depressions, provided the contraction be unequal in different parts.

2. Apparent elevations, as a consequence of the depressions; that is, elevations as compared with the lowest level, or with a body of water occupying the depressions.

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* We may here mention one or two facts in corroboration of the general theory, that the more igneous portions of the globe have contracted most and thereby became submerged. For example, we find the continent of America reduced to a narrow strip of land, just where the great American tract is crossed from east to west by a region of igneous action, not yet entirely extinct; that is, about the West Indies and the adjoining isthmus. This region became thus depressed and submerged, in consequence of greater contraction below; and hence North and South America are nearly disjoined by a broad arm of the ocean. This single instance is the only one, through the continent of America, of volcanic eruptions east of the great western chain of mountains.

Again, the East Indies, another region of perpetual fires, in the earth's history, constitute a cluster of islands separating from Asia the large non-volcanic New Holland, properly a part of a southeastern extension of the continent. Moreover, we may account for the fact that this Archipelago has not farther subsided, so as to become a deep ocean with few islands, on the ground that extensive areas of land, without fires, exist in the midst of the group, Borneo being one example, equalling in extent half the United States, east of the Mississippi. The Indian Ocean, at the same time, bears evidence in its coral islands of a much more extensive subsidence.

† See this Journal, ii, ii ser., 355. While thus mentioning the name of M. C. Prévost, we should remember that the theory of contraction, as a cause of the earth's features, dates as far back as Leibnitz, many of whose speculations in science are proving to be as well founded as the rigid results of his mathematics. And among the geologists of the present day, De la Beche especially has insisted upon this agency as the general cause of the unevenness of the earth's surface, though he stops by stating some of the grand results, without allowing them their full influence as laid down by Prévost. Mr. Lyell, in his *Travels in North America*, has made a partial application of the principle to the Appalachians.

The writer does not claim to have presented any new principle, except it may be the special cause assigned for the oceanic depressions; and whether this holds true, remains for the future to determine.

3. Fissures.

4. Ejection of igneous matter, at times, through fissures.*

5. Upheaval along a line of fissure, the surface adjoining being more or less raised.

6. Upliftings and foldings from lateral pressure.—An arc of the exterior surface being greater than any corresponding arc below the surface, a depression of the hardened exterior, produced by the cooling beneath, would in some instances cause lateral displacements.

7. An *unequal rate* of subsidence over given areas in different periods.—Contraction tends to occasion a strain upon the cooled and unyielding exterior, accompanied generally by a consequent diminished rate of subsidence, or a cessation of it. This strain increases till it results in fractures; and following this crisis, subsidence would for a while be more rapid in rate. The strain, or state of tension, might also occasion elevations in some places, within or without the area; and at the time of fissuring, there might be other upheavals. It follows, hence, that—

*a.* There would be prolonged intermissions in the subsidence of given areas; and this must have been the fact throughout the history of the globe.

*b.* There must have been oscillations in the land as compared with a water level, the water at times rising gradually over land that, during a previous period, had emerged; and the reverse.

*c.* There might be in the same epoch, under such circumstances, an unequal retreat of the ocean from the coasts of different continents, or a rise in one place and a retreat in others: for the changes by contraction are supposed to have been every where in progress at the same time, and throughout different in character and extent.

*d.* Changes of level may in some cases have been *gradual*, and in other cases *paroxysmal;* for the opening of large fissures would often be of the latter character.

8. In an elliptical area of contraction, there will be two systems of fissures at right angles with one another, as follows from the calculations of Wm. Hopkins, Esq.† But if the area is bounded on one side by a region participating but little in the contraction, the effects would be most decided on the borders of such a region; and they would consist in extensive fissures ranging along

* Prévost argues that all eruptions of igneous matter have arisen from the collapsing of the surface upon the fluid of the interior, which is thereby pressed out. This is a probable effect of the contraction going on, though it seems to be extended too far to include with it all the eruptions of volcanoes.

† Trans. Camb. Phil. Soc., vii, 22.

the area, and an attending swelling of the surface, or else a rising of the strata into folds by lateral pressure.*

The effects of lateral pressure might in many parts be local or of very limited extent. A contracting area might be made up of several separate areas of contraction not acting together upon any particular line. Even supposing a whole quarter of our globe to exert laterally all the force possible, by a uniform contraction continued till the surface was depressed eight miles in depth, the whole effect would be equivalent to a lateral dislocation of only twelve miles. And in this calculation, we make no allowance for upliftings over the contracting area, which would diminish the action; nor for a diminution of breadth in the surface of the area, which diminution must be going on if the surface is losing heat. In the remarks which follow relating to this point, America, therefore, is not instanced as an example of what *must every where* have happened, but of what *has here* happened.

The foregoing are the obvious effects of contraction. A *Prince Rupert's drop* (a drop of unannealed glass) may be referred to for farther illustration. The exterior, owing to its cooling first, is under strong tension, and each particle (or section) in the surface, presses laterally upon its neighbor like a stone of an arch upon the one adjoining; and hence the effect of a simple scratch in causing it to break to pieces, explosively. The earth, had it cooled uniformly over the whole exterior, (and were it made of a uniform homogeneous material,) would have been in the same circumstances, the whole crust being under immense tension, yet every where balanced, and therefore not apparent; but cooling unequally, the same actual amount of force has been exerted, yet at different periods, producing, in different parts and in different periods, fractures, depressions and upliftings.

We comprehend the effects described more clearly if we remember, as we ought, the common statement, that the highest

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* With regard to the *folding* of strata by lateral pressure, the theory was first presented by Sir James Hall, (Trans. Roy. Soc. Edinb., vii, 85,) and the injection of granite, coupled with the elevation of the land, was suggested by him as a probable source of the pressure in the instances he mentions. Scrope, reasoning on this subject, says, in his work on volcanoes, published in 1825, "There is reason to conclude that in most instances, the raised strata, particularly those which were only partially indurated, have been contorted and bent into repeated foldings, so as to give the appearance of frequent alternations of different series of strata to what is in reality but the replication of the same original series."—p. 201. De la Beche applies the theory to the structure of the Alps, (Geol. Researches, 129,) the possibility of which application was suggested by Sir James Hall.

Authors have generally followed Sir James Hall in considering that besides the lateral pressure, pressure *from above* is essential to this result. But since the soft strata are *inelastic*, and moreover, in themselves *are of vast weight*, we may conclude that there is sufficient vertical pressure independent of any foreign source. A small hand model appears to be as suggestive of error in this case, as a child's model of a bridge to the inexperienced bridge builder.

mountains of the earth are about equal in comparative altitude to the thickness of the cracked varnish on a twelve inch globe.

We remark, again, that we exclude none of those causes of elevation usually recognized, which facts show to have been in operation, though allowing them only a subordinate place.

From these explanations, we proceed to the application of them.

If the reader will place before him a good map of North America, he will perceive at once the effects which have been alluded to exhibited on a grand scale, on both sides of the continent. On the *Atlantic* side, the Appalachians, from Maine to Georgia, consist of rock strata, which have been variously folded up into ridges, as has been made out with great beauty and fullness by Professors W. B. and H. D. Rogers.* These folds are in several series, but are nearly uniform or parallel in position. As should be expected from the nature of the cause, the plications are more frequent and abrupt on the side of the chain nearest the ocean, and gradually die out westward just beyond the limits of the Appalachians. As another result of proximity to the contracting area, the rocks on the eastern side have been most altered by fire. To so great a degree has the heat operated, (which escaped by the opened cavities and fissures, and was distributed laterally by the aid of the contained and incumbent waters,) that it is difficult in New England to distinguish the true igneous rocks from those that are metamorphic.

On the *Pacific* side of the continent, we observe the Rocky Mountain range rising with a gentle swell from the coast. From the mouth of the Kansas to the top, and on the opposite or western side, the average slope is hardly twelve feet to the mile.† The summit is about eight thousand feet high. But there are ridges which add five or six thousand feet to the chain: these form a crest to parts of the range, but are not properly the range itself, though often so recognized. The Rocky Mountains appear, then, to be another effect of contraction, viz. a gradual swelling of the surface, accompanied by fissures and dislocations over its area. These dislocations are very marked in the sandstone, just east of the summit. Thus each great oceanic depression, the Atlantic and Pacific, has its border range of heights thrown up by the very contraction which occasioned the depression; and between lies a vast plain, scarcely affected at all by these changes, the great central area of the continent. This view is farther sus-

* Trans. of the Assoc. of Amer. Geol. and Nat., 1840, 1842, p. 474, and this Journal, xliii, 177; xliv, 359.

† See the section of the region between the mouth of the Kansas and Fort Vancouver, by Captain Fremont, in the Report of his Exploring Expedition to the Rocky Mountains in 1842, and to Oregon and North California in 1843, 1844. Printed by order of the Senate of the United States, Washington, 1845.

tained by finding that the effects of fire are most apparent on the ocean side of the mountains, precisely as about the Appalachians, yet to a more remarkable extent.* Indeed, there are no remains of volcanoes, or their ejections, to the east of the summit; while to the west, the country of Oregon is in many parts buried beneath basaltic or other volcanic rocks, and several existing volcanic cones have been described. Still farther, we observe a second, a third, and even a fourth parallel range of heights from the summit of the mountains to the coast; and the third (the Cascade range) rivals the Rocky Mountains in the height of some of its snowy peaks. Vast fissures were opened to the fires below, as these ranges indicate, and some of the vents have not yet ceased action.† Here, then, are the natural effects of proximity to a region of contraction—the Pacific—in which the remains of igneous action every where abound.

It has been well established that the Appalachian folds or plications were made since the coal period, for the coal beds are enclosed in the folds;‡ and the rising of the Rocky chain was also subsequent to that era. The effect of contraction in producing these elevations, was therefore comparatively little felt in the very earliest ages, when the surface of the depressed (or igneous) portion was itself somewhat yielding, but subsequently, when it had become stiffened to a considerable depth by cooling. There appears hence to be a perfect harmony between the results and the causes adduced.

If these conclusions are correct, we must give up the popular idea (at least as a general theory) of the elevation of mountains by a force below causing at the time an irruption of igneous matter; for the irruption is in general an effect of a very different action, as has been urged by Prévost. This may be as true of the Urals, as of the Rocky Mountains and Andes.

Even the trap dykes of New England and New Jersey, whose general course corresponds with that of the Appalachians, may be a result of the contraction in progress subsequent to the coal

* The same is the general character of the Andes. In an account of the geology of Chile, M. I. Domeyko says, speaking of the Andes in the latitude of Copiapo, "En regardant du côté de l'Ouest, on voit un bouleversement complet dans le terrain soulevé: des failles et déchirements, des escarpments à pic, des stratifications contourneés et interrompues. En portant ensuite la vue du côté de l'est, on voit des pentes douces, des bancs de rochers presque horizontaux et rarement interrompus."

"Tout announce que le principal mouvement qui survint à l'époque de la formation des Andes arriva *du côté de l'Ouest*, c'est-à-dire du côté où une ligne d'escarpments qui marquent le rivage actuel de l'Ocean depuis le Cap Horn jusqu' aux Montagnes Rocheuses, continue à se soulever d'une manière lente et à peine perceptible, au mugissement des bruits souterrains et sous l'influence des tremblements de terre répétés."—*Annales des Mines, iv ser.*, ix, 413, *2nd. liv.*, 1846.

† Granites may have been the earlier products; but the existing volcanic mountains have basalts and trachytes for their surface rocks.

‡ W. B. and H. D. Rogers, Trans. Assoc. Amer. Geol. and Nat., 1840-1842, p. 522.

era. The dip of the new red sandstone accompanying them is probably another effect. The Ozark mountains, forming a line parallel with the Appalachians, beyond the Mississippi, may be referred to the same system of changes.

The economical advantages belonging to the features of North America that have thus originated, are most remarkable, and this view of their origin gives them increased interest. The Silurian rocks indicate that before the coal period the region was comparatively level, and lay mostly beneath the sea. As it emerged it was still dripping with water, so that, under a climate peculiarly genial, coal vegetation might have grown luxuriantly. But had it continued thus flat to a later period, it would have had but small streams, and probably, for want of a mountain barrier to intercept the *drying* Pacific winds, the desert regions of the west would have traversed the land, as Sahara has spread over Africa. As if to prevent these results, and give a vastness scarcely equalled to its resources, the land was raised into mountains on either coast, those of the west, where the barrier was most needed, ascending even to the regions of perpetual snows. The whole interior is now enclosed by the Rocky Mountains on the one side and the Appalachians on the other, and a thousand streams are set in motion over the wide land from either bound, all to contribute to a common trunk, the great highway of the country. Thus the largest possible extent of intercommunicating inland waters has been secured; and for the same reason a great part have been made to flow so nearly on a plain as to afford navigation almost from one end of the territory to the other, and extend their fertilizing influence over the whole surface. A similar result has been produced on the narrow ocean side of the main chains by the succession of parallel coast ranges; for the waters have been compelled to flow far north and south between these ranges, and fertilize an extended country before the sea was reached. Thus the noble Columbia, with its wide spread tributaries, was made for Oregon; and in the same manner were formed the Willammet, the Sacramento, and the Joachim, which run in long courses between the Cascade and Coast ranges of heights. Thus on the Atlantic side, we have the Shenandoah and other head waters to the Potomac, and at the north, a Hudson, Connecticut and Merrimack flowing in parallel lines.

*Note.*—In connection with this article, it should have been earlier mentioned that the theory of "secular refrigeration" has been presented with much force, in many points of view, by W. W. Mather, in this Journal, vol. xlix. p. 284, (1845), and the foldings of the Appalachians are attributed by him to this cause.

ART. XIV.—*Description of two New Species of Shells;* by WILLIAM CASE, Cleveland, Ohio.

*Helix annulata*—(figs. 1, 2, 3.) Shell minute, much depressed—umbilicus showing all the volutions; aperture simple and some-

Fig. 1.

Fig. 2.

Fig. 3.

what oval; whorls four, banded by thin, sharp and parallel ribs, inclining slightly forward; intercostal space marked with waved lines, running parallel with the whorls; nearly transparent; diameter about one line.

This minute but beautiful shell was found by Captain B. A. Stanard, in the region about Lake Superior, and I have heard of its being observed in other places, but so far as I can learn, it is undescribed. It differs from any description of the *pulchella* I have yet met with, in having uniformly an *oval* aperture and *simple lip*. The *H. minuta* of Say, I believe never has the parallel ribs, and is supplied with a lip.

*Planorbis multivolvis*—(figs. 4, 5.) Shell about five-eighths of an inch in diameter; whorls seven, about half of the last whorl overlapping the preceding one, sometimes the last whorl suddenly distorted and expanded for the last half of its length; right side concave, left side slightly accuminate and considerably carinate; throat campanulate; aperture opening towards the left, but projecting on both sides beyond the preceding whorl.

Fig. 4.

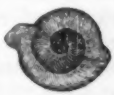

Fig. 5.

This shell, also, I obtained from Captain Stanard, who found it in the northern part of Michigan. It is very distinct from any Planorbis I have met with, or have been able to find any description of. I have named it from its strong characteristic—a greater number of whorls than usual in the genus.

*Note.*—The Helix here described approaches the *pulchella*, (*minuta* of Say,) a ribbed variety of which is called *H. costata;* yet it appears to be a distinct species. The Planorbis is most nearly allied to the *P. campanulatus.*—A. A. G.

## SCIENTIFIC INTELLIGENCE.

### I. Physics and Chemistry.

1. *Gun-Cotton.*—It was announced last summer by Prof. Schönbein of Basle, that he had discovered a method of producing a substance from vegetable fibre, more explosive and powerful than gunpowder, and much interest was excited at the late meeting of the British Association, by an exhibition of its wonderful effects. It has since been made by many persons in Europe and throughout our own country.

It is now well known that the "Gun-Cotton" is only a form of the Xyloidine discovered by Braconnot in 1833, and subsequently more fully described by M. Pelouze* in 1838. The Xyloidine is produced by the action of strong nitric acid, specific gravity 1·5, upon starch or any form of vegetable fibre. M. Pelouze stated (in 1838) that it was very combustible, took fire at 360°, and burnt with vivacity. He also suggested that it might, from its extraordinary combustibility, prove valuable in artillery. Prof. Schönbein and his associate M. Böttger claim therefore only the application of this remarkable substance to useful purposes, for although the method employed by them in its production has not as yet been made public, there can be no doubt that it is chemically identical with the Xyloidine of Braconnot and Pelouze. The suggestion thrown out eight years ago by M. Pelouze, regarding its possible application in artillery, seems to have escaped attention, and to have been productive of no useful result.

The complete conversion of cotton into Xyloidine is somewhat difficult, and requires the strongest nitric acid. In principle, it is immaterial whether the strong nitric acid be procured by distillation; by mixture of sulphuric acid with the aqua fortis of commerce; or by the mixture of equivalent parts of nitre and sulphuric acid. The best action of the nitric acid is produced by mixing with it nearly its own volume of strong sulphuric acid, which by its attraction for water renders the nitric acid of the greatest strength without interfering with the result. If 100 grains of clean carded cotton are immersed for four or five minutes in a mixture of $1\frac{1}{2}$ fluid ounces of strong nitric acid (Sp. Gr. 1·45) and an equal measure of strong sulphuric acid, it will be converted into Xyloidine. It is then removed from the acid, pressed with a spatula, and quickly washed in an abundance of cold water until it has no longer an acid reaction, when it may be carefully dried at about 200° F., again carded, and it is fit for use. As thus prepared, it retains the appearance and fibre of common cotton, but is harsher and more wool-like to the touch. It inflames at a temperature of about 350° F., and, as is lately asserted,† it sometimes happens that it is spontaneously inflamed at 212° F. The greatest caution is therefore required in the preparation, to avoid its accidental combustion.‡

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* Comptes Rendus, Oct. 15, 1838. † L'Institut, No. 670, p. 367.

‡ It may not be amiss to mention in this place, that the writer and his assistant were both burned by the accidental combustion of about 1200 grains of gun cotton, which they were drying over a hot-air flue where the temperature was probably very little above 212°. At the instant when they considered the mass as dry, it took fire and was dissipated in a large volume of brilliant yellow flame, without

It burns with a voluminous yellow flame, very brilliant and rapid, produces no smoke or odor, and leaves little or no residue. If well prepared, the products of its combustion are only gaseous. It burns so much more rapidly than gunpowder, that the latter is not inflamed by it; and not the least inconvenience is felt by burning a flock of it on the naked hand. It detonates with some difficulty when struck with the hammer on an anvil, and only in the part receiving the blow, the remainder being scattered about. Wetting does not injure it, if it is again carefully dried. Its projectile force is much greater than that of gunpowder, and has been variously stated by different experimenters as from four to eight times more powerful.

Dr. Otto states that a charge of $1\frac{1}{4}$ to $\frac{1}{2}$ grain, propelled a ball through an inch board of hard wood; and with a charge of from 4 to 8 grains, balls were projected from a gun with the best effect at 45 paces distance.* Dr. Samuel L. Dana, of Lowell, has made the most extensive experiments on the power of cotton-powder which to our knowledge have been made in this country.† His trials were made at the powder mills of Mr. O. M. Whipple, near Lowell, with an eprouvette, or proof-mortar, carrying a 24 pound iron ball, at an elevation of 45°. The projectile force of the gun-cotton was greatest when it was loosely packed in the chamber of the eprouvette, leaving the greater portion at the breech, on which the ball rested. "'Two balls were used differing a little in their windage. Four qualities of gun-cotton were used; the first was immersed 25 minutes in the mixed nitric and sulphuric acids. No. 2, the same immersed, after drying, in fresh acids for 25 minutes more. No. 3, dipped 25 minutes, and then a new portion of fresh acids added, and the dip continued for the same time longer. No. 4, called 'blasting cotton,' dipped 35 minutes. Two discharges of Mr. Whipple's best rifle powder F F F F, were first made, each one ounce. No. 1 threw the ball 288 yards. No. 2 threw it 272 yards. Average $281\frac{1}{2}$ yards. The chamber was then cleaned and charged with gun-cotton.

| No. of discharges. | Quality of gun cotton. | Quantity in ounces. | Yards projected. | REMARKS. |
|---|---|---|---|---|
| 1 | 3 | $\frac{1}{8}$ | 7 | Charge loose in chamber, that not full, ball No. 2. |
| 2 | 3 | $\frac{1}{2}$ | 100 | Chamber full, hard rammed, and small wad over cotton, ball No. 1. |
| 3 | 3 | $\frac{1}{2}$ | 175 | Loose, and a little for a bed for the ball, ball No. 2. |
| 4 | 2 | $\frac{1}{2}$ | 272 | As in 3d shot, but more bed, ball No. 1. |
| 5 | $\frac{2}{3}$ No. 2 / $\frac{1}{3}$ No. 1 | $\frac{3}{4}$ | 453 | Charge as in 4th, ball No. 1, buried 3 feet in the ground on falling. |
| 6 | 1 | $\frac{3}{4}$ | 100 | Charge as in 4th, ball No. 2. |
| 7 | 4 | 1 | 567 | Charge as in 4th, ball No. 1. |
| 8 | 4 | $\frac{1}{2}$ | 50 | Charge rammed hard home, ball |

smoke or odor, and with so little noise as not to attract the attention of those in an adjoining room, although the doors were open. No nitrous acid fumes were observed as others have asserted, nor was the presence of this gas detected in the small apartment. Later experiments have convinced us the cotton-powder is sometimes inflamed at a temperature even lower than 212°. B. S., Jr.

* L'Institut, No. 670, p. 366. † Lowell Daily Courier, Dec. 8.

No. 1. This charge was about one hour after the 7th, during which period it had been carried, wrapped tight in paper, in my hand, while searching for the ball of the 7th shot. It may have absorbed moisture.

It appears from the 4th, 5th and 7th shots, that the distance projected increases faster than the quantity."

Dr. Dana also tried the gun-cotton in blasting rocks, in the line of a new canal now excavating in Lowell. The first trial was on a ledge of argillo-micaceous slate, very hard and tough. The portion selected was imperfectly stratified in an almost vertical direction, with a perpendicular face about 9 feet high. Two holes each $1\frac{3}{4}$ inches diameter, were drilled into this rock $5\frac{1}{2}$ and 6 feet from the face, 12 feet asunder, and about 9 feet deep. Gun-cotton (No. 4 above) was enclosed in cartridges of cotton cloth, $1\frac{1}{2}$ inches diameter, and respectively 2 feet 10 inches, and 5 feet long, holding 9 and 11 ounces. The holes were filled with dry sand over the cartridges, (5 feet over one, and 6 over the other,) which were then fired by an attached fuse. The explosions occurred within a few seconds of each other, with a sharp but not loud report, and very little smoke. The result was highly satisfactory to the engineer and contractors under whose inspection the experiment was tried. The mass of rock moved was $25 \times 5 \times 9$ feet $= 1125$ cubic feet, or about 90 tons weight, moved by 20 ounces of gun-cotton! The contractors declared that 10 or 12 pounds of ordinary powder would have been required to do the same work, or eight times as much as was used of gun-cotton. In a second experiment, 78 ounces 6 drachms of gun-cotton were fired in a hole 5 inches diameter and $9\frac{1}{2}$ feet deep, and moved a mass of $45 \times 10 \times 9\frac{1}{2}$ feet $=$ about 350 tons. The gun-cotton used in these experiments was prepared by Dr. Dana after the method proposed, and successfully employed by Mr. A. A. Hayes, of Roxbury, which is substantially the same as that already described.

Some experiments on the cotton-powder in mining have been made in Cornwall by Prof. Schönbein and Mr. R. Taylor,* and with the most satisfactory results. It was found practicable to enter immediately after explosion into a narrow adit 600 or 700 fathoms from day, where it would not have been possible to have entered under three quarters of an hour, if a like amount of common powder had been burnt there.

The action of nitric acid in producing a highly inflammable substance, is by no means confined to cotton. M. Pelouze, in 1838, observed that common unsized paper, after similar treatment in strong nitric acid, became remarkably tough, quite impervous to water, transparent, resembling vellum, and very inflammable. He has lately informed the Académie des Sciences at Paris, (Nov. 2d,) that he has prepared an explosive paper, one and a half grains of which was as powerful in a pistol, as the common charge of best gunpowder. Flax and other fibres have been prepared in the same way.

The analysis of Xyloidine, by Pelouze, gives for its composition $C_6 H_4 NO_9$, or doubling the formula $C_{12} H_8 N_2 O_{18}$. Cellulose, starch, or clean cotton fibre, may be expressed by the formula $C_{12} H_{10} O_{10}$. Xyloidine may then be considered as cellulose, in which a part of the hydrogen is replaced by nitrous acid. Substitutions of this sort have

* Chemical Gazette, London, Nov. 1, 1846.

been fully established by the late researches of Laurent, Hoffman and Muspratt, which have shown that the elements of nitrous acid may, like chlorine and bromine, replace the hydrogen in many organic compounds. In conformity to this view, the formula of xyloidine will be $C_{12}\ H_8\ 2NO_4\ O_{10}$, in which the elements of two equivalents of nitrous acid are substituted for two of hydrogen in cellulose.

The arrangement of its elements is such as to produce in its combustion an immense volume of permanent gases and elastic vapor, on whose instantaneous evolution the force of the gun-cotton depends. In the production of the gun-cotton by the process described, two equivalents of hydrogen from the vegetable fibre react with two of nitric acid to form two of water and two of nitrous acid; the latter enter into the constitution of gun cotton, while the water formed remains in the acid mixture, and so far dilutes it as soon to render it unfit for use. Hence the necessity of changing the acid liquor. In dilute nitric acid the xyloidine dissolves, forming oxalic acid. When, in its preparation, the gun-cotton is seen to become gelatinous and semitransparent, it is a sign that the acids are no longer of a sufficient strength to produce the explosive compound.

2. *On the Compounds of Phosphorus and Nitrogen;* by C. Gerhardt, (Comptes Rendus, 1846.)—Two compounds of phosphorus and nitrogen have been supposed to exist, the one $PN_2$, the other a hydrate $PN_2+HO$. This composition being contrary to the views of Laurent and Gerhardt, the latter undertook the reëxamination of the subject. He found that the so-called phosphuret and its hydrate were mixtures of three substances named by him *phosphamide, biphosphamide* and *phospham.*

*Phosphamide.*—When ammoniacal gas is made to pass over chlorid of phosphorus contained in a long tube, the chlorid becomes heated and gives off much sal-ammoniac. The product (a white powder) treated with water, dissolves in part only; the insoluble residue is impure phosphamide, which is purified by boiling for several hours in a dilute solution of potash, then in weak nitric acid and lastly in water; dried at 212° its formula is $PH_3N_2O_2$.

This substance heated in a metallic bath loses not a trace of water; above 390° it gives off pure ammonia and is converted into biphosphamide.

The formation of phosphamide is represented by the following formula: $PH_3O_3+2(NH_3)-6(HO)=PH_3N_2O_2$.

*Biphosphamide* is formed when dry phosphamide is heated, all the hydrogen goes off as ammonia, and there is left $PNO_2$. Moistened with water and heated, this substance gives phosphoric acid and ammonia. Melted with caustic potash, this as well as the former forms phosphate and gives off ammonia. This is remarkable as being the first amide not containing hydrogen, and on this account Gerhardt says it "must sorely puzzle the advocates of radicals and the dualistic theory."

*Phospham.*—The product of the action of ammonia upon the perchloride of phosphorus gives off, when heated, sal ammoniac and hydrochloric acid. The white residue has been considered phosphuret of nitrogen, $PN_2$; it is however a mixture, and minute precautions are necessary to produce the pure phospham, $PHN_2$. The presence of hydrogen was supposed by Liebig and Wöhler to be accidental. There is, however, 1·5 per cent. of hydrogen in this substance. Fused potash

converts it into ordinary phosphate; moistened and quickly raised to a red heat, it disengages much ammonia and is converted into metaphosphoric acid. G. C. SCHAEFFER.

3. *Experimental Researches on the Nutritive Power of green and dry Fodder;* by M. BOUSSINGAULT, (Ann. de Chim. et de Phys., July, 1846, and Comptes Rendus, Apr., 1846.)—It is generally thought that there is more nourishment in green fodder than in the dry hay derived from an equal weight of the fresh grass. The experiments of Boussingault show that this is not true. A heifer was weighed, and fed for ten days on green fodder, each day a quantity equal in weight to that consumed was put aside to dry. The animal was again weighed and fed for ten days on the dry fodder, then weighed again. The experiment was tried three times, and each time the animal weighed a little more after feeding on the dry fodder than after the green. The difference was not enough to prove that the dry food was the *more* nutritious, although the experiment proved beyond a doubt, that it was not inferior in effect to the other. G. C. S.

4. *On the progressive development of Vegetable Matter in Wheat;* by M. BOUSSINGAULT, (Ann. de Chim. et de Phys., June, 1846.)—M. Matthieu de Dombasle has endeavored to overturn the common opinion that plants exhaust the soil only during the formation of the seed; he asserts that a plant at the time of flowering, contains all the elements required to bring it to maturity.

The experiments made by Boussingault to decide this question, were carefully conducted. An equal number of plants drawn the 19th of May, the 9th of June when in flower, and the 15th August at harvest, furnished the data. The plants were not only dried and wiped, but submitted to organic analysis.

The results when calculated for a hectare, were as follows: The assimilation of dry vegetable matter, from the time of sowing to May 19th, was 6·8 kil. per day; from May 19th to June 9th, 32·9 kil. per day; and from June 7th to Aug. 15th, 36·3 kil. per day. Thus the most rapid growth was before the time of flowering, but still the crop had nearly doubled in weight from the time of flowering to the harvest. The increase of organic matter was nearly in the same proportion. G. C. S.

5. *Memoir on Coffee;* by M. PAYEN, (Comptes Rendus, May and July, 1846.)—Our knowledge of this important substance, is as yet but scanty. Caffeine, legumine, oleic acid and palmitic acid, are almost the only ingredients, the existence of which has been satisfactorily proved; and the small quantity of these, shows how little of the active matter in coffee is really known to us. The researches of Payen, not yet concluded, are highly interesting, and have already brought to light a new and very singular compound, presently to be described.

The first part of the memoir consists of certain estimates of the amount of nutritious and soluble matter contained in the raw coffee and in that which has been more or less roasted.

Martinique coffee gave 40 per cent. soluble matter; 11·5 hygroscopic water, and 45·5 insoluble matter. The ease with which the soluble matter is removed, depends upon the fact, observed under the microscope, that the hard substance of the grain is traversed by irregular cavities opening into each other and containing the soluble matter.

Coffee roasted only until it becomes slightly red, preserves the maximum of weight and of aroma, but gives out less coloring matter. In this state, 100 parts are found to have lost 15, while 100 vols. have increased to 130. Roasted to a chesnut color, as is commonly done, the loss is 20 per cent., while the increase in volume is from 100 to 153. This swelling of the grain depends upon the property which the nitrogenous matter deposited within the tissue has, of puffing up remarkably when heated.

If the heat is continued until a dark brown color is produced and the grain becomes covered with a sort of glaze, the loss is 25 per cent., while the original quantity of nitrogen, 2·45 per cent., is reduced to 1·77, being a loss of one fourth.

The loss of soluble matter was found to be proportionate to the loss in weight, but in order to obtain results of practical value, instead of exhausting the coffee, the usual domestic process was tried. One litre of water (nearly 1 qt.) was filtered through 100 grammes (1500 grains) of each kind, and there was obtained of soluble matter from the brown coffee 16·15; from the chestnut, 19·00, and from the red, 25·00.

The difference in the aroma being nearly the same, the lower degree of roasting will produce not only the best and most nutritious beverage, but one free from the harsh and bitter flavor caused by action of too high heat upon the nitrogenous matter.

The nature of the substances dissolved, renders this beverage not only agreeable but nutritious, compared with tea (the coffee being 100 gram. to one litre of water, the tea 20 gram. to one litre); the former contains three times the quantity of solid matter and double the nitrogen, of the latter. With an equal bulk of milk, and the usual amount of sugar, this drink contains six times the solid, and three times the nitrogenous matter that broth does.

The partial substitution of succory for coffee, was proved to be without real advantage, as the latter substance contains a much smaller amount of nutriment and little or no aroma, but more coloring matter.

*New double salt and acid of coffee. Direct extraction of caffeine.*—The new compound discovered by Payen, appears to have escaped notice, by reason of its remarkable disposition to change. In fact this change is the first evidence of the presence of the matter. A simple infusion of the raw coffee, although nearly or quite colorless, on the addition of a few drops of ammonia, turns first at the surface, and gradually throughout, to a bright and finally to an intense green. By hastening this action, a very delicate test was obtained for the new substance, and at last after much trouble, the means for its separation were perfected.

The process adopted affords caffeine as well as the new substance. Coffee is reduced to powder, exhausted with ether, the solution evaporated to dryness, and the fatty residue well washed with boiling water. The washings evaporated, leave a yellowish brown substance, which, treated with absolute alcohol, gives on evaporation, crystallized caffeine—the usual washing with cold, and crystallization from hot alcohol, furnish it perfectly pure.

Having obtained the equivalent of this substance, Payen was able to control the analysis, which is different from that hitherto received. His formula is $C_{16}H_{10}N_4O_3$.

The coffee which has been washed with ether is, in the next place, exhausted in the alcohol of 60 per cent., and the solution evaporated to a syrup is mixed with three times its volume of alcohol of 83 p. c. The liquid separates into two portions, the lighter and more fluid of which contains the new compound. After decantation, the further purification depends upon the solubility of this substance in weak alcohol and water, and its insolubility in absolute alcohol. The aqueous solution alters so rapidly that in all cases alcohol must be added, and even the alcoholic solutions must be evaporated without exposure to the air.

This remarkable crystalline compound when pure, contains a new acid, called by its discoverer, from its singular properties, *chloroginic acid*, besides caffeine and potash; in short, it is a *double chloroginate of caffeine and potash.*

The most striking properties of this salt are—1st, its alteration, marked by the development of an intense green color, under the influence of air and ammonia; and this property is the best guide to its preparation; 2dly, the action of heat, which increases its bulk five times, causes caffeine to sublime, and finally at a high temperature leaves a residue having twenty times the volume of the original substance. It is this property which occasions the swelling of the grain when roasted; the salt may be discovered by the microscope already formed in the coffee.

The alteration of the double salt, by ammonia, when carried to completion, or the moderate action of heat, permits the separation of the caffeine unchanged. Precipitated by tribasic acetate of lead, the chloroginate of lead may be obtained pure, and by decomposition by sulphuretted hydrogen the acid is easily obtained and purified. The formula of chloroginic acid is $C_{14}H_8O_7$.

(Caffeine is thus brought to resemble sugar of gelatine in its union with an acid, while the new acid itself differs from kinic acid by only one equivalent of oxygen. The further investigation of these substances will undoubtedly lead to some striking analogies.) G. C. S.

6. *Researches on Blood;* by M. Dumas, (Ann. de Chim. et de Phys., August, and Comptes Rendus, June, 1846.)—These investigations are based upon the process of MM. Lecanu and Figuier, by which the globules can be obtained free from all mixture or impurity. Their method consists in mingling the blood with three or four times its volume of a saturated solution of sulphate of soda. On filtration, the liquid passes clean and colorless, while the globules remain upon the filter. The blood however must be freshly drawn, or the addition of even large quantities of the saline solution will fail to give a colorless liquid. Moreover the attempt to wash the globules by a new quantity of the solution was not successful, and without this washing they retain a notable proportion of the serum.

In attempting to overcome this difficulty, M. Dumas discovered the remarkable property of the blood globules, that as long as they were in contact with the air or aërated water, in short as long as they were in the arterial condition, the saline solution containing them passed colorless through the filter, and left them upon it; on the contrary, as soon as the globules have assumed the violet tint of venous blood, the liquid passes colored.

It is only necessary then to pass a continuous and rapid current of air through the solution upon the filter, to maintain the globules in the proper condition. The blood as soon as drawn is defibrinated, mixed in the saline solution, and thrown upon a large filter. A tube in the point drawn out introduces the current of air, which also keeps the globules suspended—if they adhere to the filter they are no longer aërated. The solution is renewed as fast as it filters off. In this way the globules are obtained perfectly free from serum. The process should be conducted as expeditiously as possible.

Thus the globules of the blood seem to possess vitality, as they can resist the solvent action of sulphate of soda as long as their life continues, but yield to this action readily when they have fallen into asphyxia from privation of air.

Phosphate of soda and salts of organic acids are among those which best preserve the power of aëration in the blood corpuscles. On the other hand, the chlorids of sodium and potassium as well as sal-ammoniac, prevent the aëration of the globules even in oxygen. Salts of potash seem to have less of the preservative effect, than salts of soda. Dumas asks if there is any relation between these effects and the supposed liability to scurvy from the immoderate use of salt meat, or the poisonous effects of ammoniacal salts.

It appears from these experiments that even in the midst of a supply of air or oxygen, asphyxia may result simply from the introduction of salts which modify the action of oxygen upon the globules. Several curious points are suggested as subjects for experiment.

In conclusion, an analysis of the carefully purified blood globules is given—the results are, for those taken from the blood of a woman, carbon, 55·1; hydrogen, 7·1; nitrogen, 17·2; oxygen, 20·6—showing that these bodies belong to the albuminous class. The slight excess of carbon is probably owing to the presence of a coloring matter more carbonated than albumen or caseine. G. C. S.

7. *New Saccharimetric Process;* by M. Eug. Peligot, (Comptes Rendus, June, 1846.)—Peligot's method of estimating the quantity and kind of sugar, either solid or dissolved, or in vegetable juices, is unlike all others hitherto proposed. It is founded on the property the sugars possess of forming definite compounds with alkaline bases, and also upon the rapid conversion of grape sugar into acids by the action of alkalies.

Of the sugar to be examined, 10 grammes are dissolved in 75 centimetres of water; to the solution in a glass or porcelain mortar 10 grammes of slacked and sifted lime are added gradually, and the whole levigated for a few minutes. The solution is filtered, and had better be poured a second time into the filter, in order that the whole quantity of lime that the sugar can take up should be immediately dissolved.

By means of a graduated pipette, 10 cub. cent. of the solution are taken; these are to be diluted with 2 to 3 decilitres of water, a few drops of tincture of litmus are added, and the liquid is neutralized exactly by a normal solution of sulphuric acid. This solution should contain per litre, 21 grammes of pure monohydrate of sulphuric acid—one litre saturates the lime dissolved by 50 grammes of sugar. Simple inspection determines the quantity of the lime, and even of the sugar, if the division has been made for the purpose.

For sugars suspected to contain grape sugar, and also for molasses and inferior sugar, the process is conducted as before; and next an equal quantity of the solution is heated in the water bath to 212°. If nothing is presented but cane sugar, the saccharate of lime deposits, but is redissolved in cooling. If glucose is present, the liquid becomes deep brown and smells of burned sugar. A second alcalimetric trial gives only the quantity of cane sugar which remains, the whole of the glucose having been converted into acid, which neutralizes the lime in part.

When liquids are operated upon, it is convenient to have them of the density 1·05, or about that of cane or beet juice. They filter better than when denser, and dissolve the lime more rapidly than when more dilute. The quantity of lime used should be equal in weight to the sugar supposed to be in solution. G. C. S.

8. *Rapid Method of estimating Copper, by means of a Colorimeter;* by M. JACQUELAIN, (Comptes Rendus, June, 1846.)—A given quantity of pure copper, (0·5 grammes,) is dissolved in nitric acid, an excess of ammonia is added, with pure water, to make the volume of 1 litre. 5 cub. centimetres of this liquid are put into a glass tube, which is hermetically sealed. The color undergoes no change for many months. The assay is dissolved in nitric acid, and ammonia added as before. The solution is then made up to a determined volume by the addition of water, the color being kept darker than that of the normal solution. 5 cub. cent. of this liquid are placed in a tube, of the same diameter and internal thickness as those of the former. Water is then added until the tints are alike. The volume of water being known by a simple proportion, we can ascertain the quantity of copper in the assay solution and in the assay itself. The tints are best observed by placing the tubes against a sheet of white paper, and by looking through a small hole covered with a *blue* glass. The use of one eye only is necessary to success.

M. Cassaseca produced a paper on a similar process, at the same meeting of the Academy of Sciences of Paris. G. C. S.

9. *On the Molecular Phenomena of the Voltaic Arc;* by M. DE LA RIVE, (Comptes Rendus, April, 1846.)—The experiments of the author were made with a Grove battery of seventy pairs. The influence of the form and substance of the conductors upon the length of the arc, the transport of the particles from the positive to the negative pole, and the nature of the deposit, were all thoroughly examined. In most of the experiments one pole had the form of a point, the other of a plate, and the distance was accurately measured by a screw.

The maximum length of the arc between a point and plate varied from two to six millimetres. In case both were of the same substance, the length of the arc, when the point was in connection with the positive, and the plate with the negative pole, was twice as great as when the order was changed. The distance was greatest with silver, iron and charcoal, least with platinum. Between different metals, that which formed the positive pole, as a point, determined the length of the arc. The plate at the negative pole was however not without influence.

The intensity as measured by a galvanometer was found to decrease as the poles were separated, until the luminous arc disappeared. The minimum deviation was the same, whatever the nature of the substance

employed, although the maximum length of the arc varied greatly. The length of the arc probably depends upon the facility with which the particles of the substance are separated. The condition of the matter during its transport, whether liquid, solid, or gaseous, could not be determined. The appearance of the deposit, in some instances, indicated that the matter had been in a liquid or gaseous state.

The well known difference of temperature at the two poles was examined under various circumstances. M. de la Rive considers that the higher temperature of the positive pole and the separation of matter from that one alone, shows that the substance undergoes vibrations or mechanical actions, not communicated to the matter in connexion with the negative pole. A very curious experiment seems to prove that this supposition is correct.

If the poles are formed of two pointed, soft iron rods, the flame may be drawn out to a length of six millimetres. If the rods are then magnetized, (by a helix passing around them, or by contact with the poles of an electro-magnet,) the arc immediately disappears, and does not return unless the magnetic influence ceases before the rods can cool. If however the magnetism is kept up, on bringing the points together, the arc reappears, but totally different in character. The arc can now only be drawn out to one-third its former length, and consists of snapping sparks given out in every direction from the positive pole. As soon as magnetism ceases to operate upon the wires, the flame becomes quiet or assumes its original character. Two tempered steel points, before they have lost their temper by the heat, produce an arc precisely like that between the magnetized iron points. The arc is analogous to the effects of magnetism and temper upon the sound of wires.

M. de la Rive concludes with a still more curious experiment. The snapping sound produced by the magnetized rods may be greatly increased, when one of the irons is replaced by another metal, or still better by a point of coke or hard charcoal. The sound then becomes very shrill and intense, and is compared to that of a locomotive whistle; this is only while the iron is magnetized, otherwise the sound ceases, although the flame continues. But what is most remarkable, the sound is only heard when the magnetical iron is at the positive pole—at the negative pole it does not produce the slightest noise.

M. de la Rive does not appear to have examined the deposit on the *sides* of the vessels containing incandescent coal or coke points. This deposit always forms in vacuo or when the vessels are closed; it seems to indicate a much greater amount of dispersion of the matter from the positive pole, than is commonly thought to take place. With a battery of the same size as that used in the foregoing experiments, that deposit, in a short time, covered the sides of the glass vessels used to such an amount, that the light was greatly diminished. The purity of the carbon had nothing to do with this effect, which was produced when either gas-carbon, coke or charcoal was used. G. C. S.

10. *On Electro-Physiology;* by Prof. Matteucci.—(Proceed. Brit. Assoc., from Athen., Sept. 26, 1846.)—Prof. Matteucci submitted to the British Association a *résumé* of his latest researches in Electro-Physiology.—In the first place he described the experiments which prove that the development of electricity in living animals is a phenomenon peculiar to all organic tissues, and principally to muscular fibres, and

that it is a necessary consequence of the chemical processes of nutrition. Prof. Matteucci particularly wished to prove that the development of electricity in the muscles can never produce electric currents which circulate either in the muscular *mass*, or in the nerves. It is only by a particular arrangement of the experiment that we succeed in obtaining a muscular current. Further, all experiments contradict the opinion of an electrical current existing in the nerves. M. Matteucci proved that the current said to be proper to the frog, is, on the contrary, a general phenomenon which exists in all the muscles that have tendinous extremities unequally distributed, and that this current supposed to be peculiar to the frog, is only a particular instance of muscular current.

In the second place, the Professor laid before the Section his last researches 'On Electrical Fishes.'—He showed that the laws of the electrical shock of these animals, are a necessary consequence of the development of electricity which is produced in each cell of the electrical organ under the influence of the nervous power.

In the third place, Prof. Matteucci showed the relation which exists between the Electrical Current and Nervous Power. He proved that muscular contraction is always produced by a phenomenon analogous to the electrical spark, and that the electrical current does but modify the nervous excitability. On these facts, Prof. Matteucci establishes a simple theory of electro-physiological phenomena.

In the last part of his communication, the Professor treated of Inducted Contraction;—and, after having demonstrated that these phenomena cannot be explained in supposing an electrical discharge of any kind indiscriminately, he concluded, that Inducted Contraction is an elementary phenomenon of the nervous power, which acts in muscular contraction, and is analogous to all actions of induction of physical powers.

11. *Notices of the Progress of Experiments on the Influence of Light on the Growth of Plants;* by R. Hunt, (Proc. of Brit. Assoc., Sept., 1846, from the Athenæum, Sept. 19.)—The experiments described in former communications to the Association, had all been confirmed by the results obtained during the past year. It had been found that seeds would not germinate if all the chemical rays were prevented from acting on them—and that the influence of the actinic or chemical rays was such that seeds germinated at a depth below the soil, under the influence of concentrated actinic force, acting on the surface, at which they would not have germinated under the natural conditions. The leaves being developed, the action of the luminous rays then became necessary to effect the decomposition of carbonic acid and the deposition of woody fibre within the plant. Under the joint influence of light and actinism the plant arrived at maturity, and then the calorific, or heat-producing rays were brought more fully into action to produce the ripening of fruit and the development of seed.

12. *On the Results of an extensive series of Magnetic Investigation, including most of the known varieties of Steel;* by W. Petrie, (Proc. Brit. Assoc., from the Athen., Sept. 26, 1846.)—

*Process of manufacture to produce permanent magnets, having the greatest fixity and capacity conjointly secured.*—1. The original iron should be the purest soft iron, *charcoal made* (not coke); the Swedish,

from the *Dunnamore* mine, is better than any other. 2. Converted—with pure *charcoal;* it should be carbonized *lightly*, and the process to be stopped when the bars, of the usual thickness, are "*scarcely steel through*," yet so that it will harden with certainty, without an undue heat. 3. Sorted—with attention to homogeneous conversion, &c., according to the ordinary rules. 4. Melted—the pot kept covered, and not longer than necessary in fusion. 5. Cast—into a large ingot, so as to allow of its being *well* rolled out singly, before it becomes reduced to the requisite thinness. 6. Rolled—while hot from casting, to save a second heating; it should not be doubled over, nor sheared and fagotted; the rolling should be conducted at as low a temperature as convenient, as it thereby acquires a harder, closer texture, and finer grain. 7. In cutting into shape, the substance (if large or of varied form) should not be strained, as by boring with "*rymers*," or straightening (oftener than is unavoidable) with the hammer, as it is then apt to warp, and to have unseen commencements of cracks on becoming subsequently hardened. More carbonization than that previously described as best, is of little injury to the magnetic goodness of the steel, provided it be so prepared as to preserve a homogeneous and *white* appearance of fracture when hardened, which is not so easily managed as with that of lower carbonization; but if it be again carbonized *more* than usual, (as razor steel, or above that,) it rather improves; and again an increase deteriorates it as in cast iron, and a further increase again improves it. In short, *in the scale of carbonization there is a succession of continually decreasing maxima of advantage.*

*On the physical properties which the steel should possess.*—The fineness of grain is affected by many adventitious circumstances, which must be considered and allowed for in judging of it; and the most important fact is the difference between the appearance in the *hard* and *soft* states; for in the general properties, whether optical, mechanical, or magnetical, their order, in any set of samples, is *reversed* in the hard state, independently of the absolute change in each property. The steels should be examined by breaking with a *single* bend at a file notch, (notching with a chisel, bending back, &c., change the appearance.) A microscope of 6 or 10 lineal power is better than any other power for examining it. The *general* properties, without going into detailed description, should be as follows, the terms being comparative with other samples of less value, and not at all with the hard or soft states of the same steel:—

| *In a soft state.* | *In a hard state.* |
|---|---|
| General appearance, uniform darkish grey. | Uniform white. |
| Rather a large grain, compared with razor steel, (or finer if much rolled.) | A smaller grain than it was before. |
| *Rather* irregular in size and shape of grain, unless fine. Rounded crystallization. | Rather more regular than before. *Rounded* crystallization disappears. Grains individually distinct, with good metallic lustre. |
| Close texture, without cavities. | Not particularly close. |
| Rather tough for steel. | Brittle, and very hard. |
| Attracted considerably before magnetizing. | Ditto. |
| *Loses* induced magnetism more freely than other steels. | Retains magnetism well and abundantly. |

Care must be taken to discriminate between real cavities and indentations arising from the crystals being torn up by the breaking; pure iron often appears porous from this cause.

Then followed some peculiar considerations on the chemical constitution and molecular arrangement of certain sorts of steel; and on the molecular peculiarities of iron and other metals, in connexion with their magnetic capacity, illustrated by a tabular arrangement.

*On hardening, &c.*—In the ordinary process there is risk and difficulty for large work, owing to unequal heat, unnecessary time and heat applied, especially to fine edges, decarbonization, scaling, &c. These are obviated by a process which is new, as applied on a large scale, namely, heating in melted lead. It will be observed that the *precise* heat is imparted, quite uniformly, in half a minute or so; and the finest edge is heated momentarily no higher than the thickest part, rendering this process incomparable for all instruments where it is the edge or smaller parts that are of importance. *No scale is formed*, the finest polish or sharpest edge being preserved through the hardening. The previous preparation of the steel and some other points are described; and particulars of the manner of refrigeration in water (salt), and for securing hardness and great evenness, are also detailed. The process has been applied to steel sheets of 10 inches by 20, obtained quite flat, and as hard as a file throughout, even at the middle parts, which has hitherto been found very difficult—we may say impossible. Magnets, prepared by these means only, differ generally in magnetic power by $\frac{1}{10}$ part, many being absolutely equal. Particulars are then given of the advantage of certain high powers for magnetizing bars, and of an apparatus constructed, weighing 2 cwt., and possessing nearly as great aggregate power as the colossal magnet in possession of the Royal Society, (weighing, we believe, 2 tons.) A method is suggested for verifying the constancy of magneto-meteorologic instruments, by means of the terrestrial magnetism itself, independently of its own variations, or of the comparison of the mutual action of three or more bars.

13. *On the Mode of Developing the Magnetic Condition;* by Dr. Scoresby, (Brit. Assoc., from the Athenæum, Sept. 26, 1846.)—Dr. Scoresby stated that he had, at York, shown a new and superior mode of developing the magnetic condition in properly prepared and hardened steel bars, by interposing a thin plate of soft iron between the operating magnet and the bar of steel to be magnetized. He had, at that time, supposed it to be necessary to extend the thin plate of soft iron the entire length of the bars of steel to be magnetized. But he had since found this to be by no means the case; since by laying any number of unmagnetized bars of steel in a long line, and passing along them a horse-shoe magnet with its poles connected with a thin polished plate of soft iron, (he used common hoop iron,) the ends being slightly bent upwards to cause it to pass more freely over the steel bars, and then turning them over and renewing the process on the other face, he found he could communicate to the bars the full charge which they were competent to receive. The Rev. Doctor exhibited this experiment; and by simply passing a horse-shoe magnet thus armed with an interposed piece of sheet iron, once over each face of twelve previously

unmagnetized bars of steel, he communicated to them so much power that they sustained their own weight, when held up as a chain.

14. *On some Results of the Magnetic Observations made at General Sir T. M. Brisbane's Observatory, Makerstoun;* by J. A. Broun, (Proc. Brit. Assoc., from the Athenæum, Sept. 19.)—1st. *Magnetic Declination.*—The annual diminution of westerly declination at Makerstoun is 5′ 8″. When proportional parts of this have been added to the monthly means, from January, 1844, till August, 1846, their whole range is only 2′ 1″; that is to say, the mean position of the magnetic needle for any month, freed from secular change, has not been about 2′ 1″ farther west than the mean position for any other month. Mr. Broun conceives that he has found the *annual period* of westerly declination to consist of a minimum at the vernal, and of a maximum at the autumnal equinox: the mean range being under 1′ 2″. From the observations for 1843, Mr. Broun has concluded that there is a maximum of westerly declination when the sun and moon are in opposition, and a minimum when they are in conjunction; that there is a maximum of westerly declination when the moon has its greatest north, and also when it has its greatest south declination, minima occurring when it crosses the equator. In the *diurnal period*, the double maximum and minimum have been found to exist in each month of the year. In the 'Transactions of the Royal Society of Edinburgh,' Mr. Broun has given certain results relating to the horizontal and vertical components of the earth's magnetic force; but these results were obtained in scale divisions corrected for temperature by his method. In order to reduce the variations of magnetic dip and of the total magnetic force, from the variations of these components, it was necessary to determine the values of the scale divisions in known units. Mr. Broun had previously shown (Trans. Roy. Soc. Edin., vol. xvi) the inapplicability of the method given by the Committee of Physics for the Royal Society of London for the balance magnetometer. He now described a method by which the value of the micrometer divisions may be satisfactorily determined. This method will be found in the Introduction to the Makerstoun Observations for 1843. He has applied the same method to the bifilar magnetometer, and has found that the value of the scale divisions, obtained in the way recommended by the Committee of Physics, is also inaccurate for this instrument. With the aid of the values obtained by the new method, the following results have been deduced.

2d. *Magnetic Dip.*—The dip is a minimum when the sun and moon are in conjunction, and a maximum when they are in opposition. In the mean diurnal period for the year,

| | | | | | |
|---|---|---|---|---|---|
| The principal | maximum | occurs at | 10$^h$ | 10$^m$ | A. M. |
| " | minimum | " | 5 | 40 | P. M. |
| A secondary | maximum | " | 2 | 0 | A. M. |
| " | minimum | " | 5 | 40 | A. M. |

Makerstoun mean time being always used. These periods vary to some extent throughout the year, the principal minimum occurring at 6 A. M. in winter; the two minima being nearly equal to the equinoxes, and the diurnal curve being single in summer. Mr. Broun has found that there is a maximum of dip about four hours and a half before the moon's passage of the superior meridian; a minimum about half an

hour after that passage; a secondary minimum about three hours after it; and a secondary maximum about eight hours after it.

3d. *Total Force of the Earth's Magnetism.*—A minimum occurs when the sun and moon are in opposition, equal maxima near the quadratures, and a secondary minimum at the time of conjunction. In the mean diurnal period for the year,

| | | | | |
|---|---|---|---|---|
| The principal | maximum occurs at | $5^h$ | $40^m$ | P. M. |
| " | minimum " | 2 | 10 | A. M. |
| A secondary | maximum " | 7 | 10 | A. M. |
| " | minimum " | 10 | 10 | A. M. |

The periods of maxima and minima shift about two hours in the course of the year, and in summer the principal minimum occurs at $10^h$ $30^m$ A. M. The variations of force with reference to the moon's hour angle were found by Mr. Broun as follows:—The principal maximum occurs about two hours after the moon's passage of the inferior meridian; a secondary minimum about four hours before the passage of the superior meridian; a secondary maximum about one hour after the superior passage; and the principal minimum about six hours and a half after that passage. Curves were exhibited illustrating these results, and also the diurnal motion of a magnetic needle freely suspended in the direction of the magnetic force. From the latter some curious results have been deduced, which will be found elsewhere. It will be enough to mention, at present, that in the mean for the year, the motion from 6 A. M. till 6 P. M. is very trifling; between midnight and 6 A. M., the needle is almost stationary, nearly the whole motion occurring between 6 A. M., noon, and 6 P. M. The end of the needle describes an ellipse whose major axis is at right angles to the magnetic meridian; but the direction of this axis varies throughout the year.

15. *Ilmenium*, (Jour. de Pharm. et de Chim., Oct., 1846, p. 304.)—This new metal has lately been discovered in a mineral which was at first mistaken for *yttro-tantalite*, but which M. Hermann (the discoverer) proposes to call *yttro-ilmenite*, because it is found to contain no tantalic or columbic acid, but in its place the oxyd of the new metal. Ilmenic acid partakes very much of the characters of columbic acid, but is distinguished by many peculiarities. Briefly—ilmenic acid has a density much less than columbic acid; it becomes very yellow by ignition; and its hydrate moistened with hydrochloric acid, acquires a blue color by the contact of zinc; it expels by fusion with carbonate of soda a much greater proportion of carbonic acid. From *niobic acid* it is distinguished by the absolute insolubility of its hydrate in concentrated hydrochloric acid, and that it does not color the bead of the blowpipe.

A characteristic reaction of *ilmenic acid* is that a solution of ilmenate of soda with hydrochloric acid, produces with nutgalls or ferrocyanid of potassium, *brown precipitates* much clearer than the hydrate of iron. Neither columbic nor niobic acid gives precipitates of so deep a color. Moreover the atomic number of ilmenium is much less than that of columbium or niobium. If we assume for ilmenic acid two equivalents of oxygen, the atomic number of ilmenium will be 62·4, (753 = Il.)

The *metal* is obtained by igniting the ammoniacal chlorid of ilmenium in an atmosphere of ammonia. It forms a porous mass, or small coherent flakes, with a soot-black color, like the carbon from burnt sugar. It does not decompose water; and is unattacked by strong nitric or hy-

drochloric acids, and even by aqua-regia. Heated in air it takes fire and burns, leaving white ilmenic acid. Its specific gravity is 4·10 to 4·20. Its sulphates, chlorid, and several of its salts have been studied and described by M. Hermann.

[M. Hermann's researches on columbium, niobium, and the new metal ilmenium, seem to warrant the conclusion that the formula $RO_2$ is the proper expression for the oxyds or acids of a large class of metals, which are usually placed in distinct groups. Thus we may put together uranium, molybdenum, tungsten, titanium, tin, columbium (tantalum,) niobium, pelopium, and ilmenium. Farther study is required before we can determine the order in which these should be grouped among themselves. But titanium, tungsten, molybdenum, niobium and ilmenium are assimilated by the fact that their acids all produce a blue color with zinc and hydrochloric acid, which Dr. Wollaston described as characteristic of columbium. The mineral from which this chemist obtained his supposed columbic acid, was from Haddam, the variety which Rose has shown to be quite rich in niobic acid. Wollaston undoubtedly obtained the niobic acid in his trials, since the pure columbic acid has not this reaction.]

## II. Mineralogy and Geology.

1. *Crystallized Carbonate of Lead, at Rossie, New York;* by G. Hadley, (communicated for this Journal.)—Small crystals, an eighth of an inch or less in length, are occasionally sprinkled thickly over the surface of the galena of Rossie, which, when this is the case, is deeply roughened or corroded. The crystals are striated prisms, terminating in four brilliant planes, two of which meet on an angle of 117° nearly, and the other two at an angle of 88°. The crystallization, as well as the blowpipe characters afterwards obtained, evince that the mineral is carbonate of lead. My attention was drawn to these crystals by Mr. O. Root.

2. *On Coracite, a new ore of Uranium*; by John L. LeConte, M. D., (from an article communicated for this Journal, which will appear in our next number.)—This mineral is from the north shore of Lake Superior, where it occurs in a vein two inches wide, near the junction of trap and syenite. It is allied to Pitchblend, from which it appears (from a quantitative analysis) to differ in the substitution of alumina for the sesquoxyd of uranium. It occurs massive without cleavage, and has a resinous lustre, an uneven conchoidal fracture, and a gray streak. H=4·5, G=4·378.

3. *Plumbo-resinite and Cupreous Sulphato-carbonate of Lead in Missouri;* by J. L. LeConte, M. D., (communicated for this Journal.) —Thin incrustations of plumbo-resinite occur on some of the specimens of the Missouri black cobalt. It has a pearly lustre, and sometimes appears metallic over the botryoidal cobalt ore, but is almost transparent when scaled off.

Among specimens from the Mine La Motte, I have detected a green mineral, varying in color from pale apple green to dark verdigris green, and having a radiated structure consisting of acicular crystals loosely aggregated. I have not yet seen perfect crystals, but from some trials have determined it to be the rare cupreous sulphato-carbonate of lead. It occurs with the oxyd of cobalt.

4. *On the Mississippi Delta;* by C. LYELL, (in a letter to the editors.)*—In a previous letter, I mentioned to you that the report of my discourse on the delta of the Mississippi, which appeared in the Athenæum Journal, Sept. 26th, 1846, although corrected by me, was no more than a brief and imperfect abstract of the Lecture which I delivered to the British Association at Southampton. It failed to embrace even the heads of many of the arguments and data, which I adduced, and as I find that it has not been so understood by all, I am desirous of supplying one or two of the most obvious omissions. In my conjectural estimate of the probable thickness of the alluvial deposit, I alluded not only to the ascertained depth of the Gulf of Mexico, between the southern point of Florida and the Balize, but also to some borings, 600 feet deep, made to the northward of New Orleans, near Lake Pontchartrain, in which the engineers say they failed to reach the bottom of the Mississippi mud. In regard to the depth of the alluvium, above the head of the delta, I remarked in my lecture, that the river, in its wanderings over the alluvial plain, had every where cut out deep channels from 60 to 250 feet deep, and that the excavations thus made had been filled again, with the exception of certain bayous and crescent-shaped lakes, which remain as monuments of some of the former positions occupied by the shifting stream. Even these lakes are by no means as deep as the ordinary channel of the river, and this kind of denudation must, I conceive, have given a considerable capacity to almost every part of the large basin, or receptacle of sediment, even if we suppose it to have been originally very shallow, which I know no reason for presuming.

I have lately received a letter from Dr. Carpenter of New Orleans, from which I am happy to learn that my friend, Dr. Riddell, is repeating his experiments on the quantity of earthy matter held in suspension in the waters of the Mississippi. It appears from the observations already made, that after duly allowing for the greater clearness of the stream when at its lowest level, the annual mean quantity of solid matter will be less than was before inferred. If, as is now anticipated, the mean should prove as low as $\frac{1}{1700}$ in weight, instead of $\frac{1}{1245}$, this diminution of nearly a fourth in the quantity of sediment brought down, will require us to lengthen proportionably the period, or minimum of time, which the Mississippi has taken to accumulate its alluvial formations. The new result will still differ remarkably from that obtained by Mr. Horner, in his measurement of the quantity of earthy matter in the Rhine at Bonn, which in volume was $\frac{1}{1600}$;† but it contrasts still more strikingly in an opposite way, from the conclusions of Mr. Everest, in regard to the Ganges, where the proportion of solid matter, during seven months of the year, (a period in which nearly the total annual discharge of water takes place,) was found to be $\frac{1}{428}$ in weight, or $\frac{1}{256}$ in bulk.‡ But in this case, we have to bear in mind not only the great height of the Himalaya Mountains, but also how much nearer the

* Dated London, Nov. 6, 1846, and intended as an addition to the article on p. 34.
† Edin. New Phil. Jour., Jan., 1835.
‡ Jour. of Asiatic Soc., No. 6, p. 238, June, 1832. See also Mr. Prinsep, Gleanings in Science, Vol. iii, p. 185. Also Principles of Geology, Book II.

course of the Ganges lies to the Equator than the Mississippi, and consequently the enormous quantity of rain which falls in the hydrographical basin of the Indian river. We must also attend not only to the number of inches which descend annually, but also to the extraordinary quantity which sometimes pours down in a single day in Bengal. If some of your numerous correspondents would ascertain the annual amount of rain in different parts of the valley of the Mississippi and its tributaries, and would publish the same in your Journal, together with all the facts hitherto known on the subject, they would render an acceptable service, not merely to the meteorologist.

5. *On the Origin of the Coal of Silesia*, (Proc. Brit. Assoc., from the Athenæum, Sept. 19, 1846.)—Prof. GÖPPERT, in his elaborate essay, endeavored to show from the number and condition of the coal fossils, and the character of the strata, that the material was tranquilly deposited; and that a large part of the coal was accumulated after the manner of peat. He has ascertained that by keeping vegetables in boiling water for three months or a year, they are converted into brown coal, and with sulphate of iron, a salt which occurs commonly in coal, it acquires at last a totally black coal-like condition. Sir R. I. Murchison expressed his readiness to receive this explanation for the origin of many coal strata; but there were other large coal fields to which the explanation would not apply at all—the materials having certainly been drifted to a distance by currents of water.

6. *Remarks on the St. Louis Limestone;* by G. ENGELMANN, M. D., (communicated for this Journal.)—The St. Louis limestone underlies the western edge of the great Illinois coal field. It is a very hard, light yellowish or grayish rock, mostly pure carbonate of lime, in some strata mixed with sand, in others including irregular siliceous masses of a dark color, or light colored thin siliceous strata. The limestone is perfectly compact and fine-grained in some strata, so as to furnish tolerably good lithographic stones; in other strata it is coarser and even completely crystalline. Its stratification is nearly horizontal, having in this neighborhood a slight inclination to the north or northeast. Its whole thickness may be between two and three hundred feet. The coal-bearing strata overlie it; below, directly upon the limestone, we have a sandy, and above an unctuous clay or shale, the whole about forty feet thick. On this shale rests a coal bed of three to five feet, the only workable one in this neighborhood, covered by a thin stratum of clay, which itself is overlaid by ten or fifteen feet of a blue or brown limestone, the uppermost palæozoic stratum in our region. The clay near our coal stratum is nearly destitute of vegetable fossils.

The St. Louis limestone forms the uppermost bed of the carboniferous or mountain limestone on the Mississippi. It is divided from the lower beds by a sandstone formation and another thin seam of coal, which here at least is quite thin. This sandstone is soft, friable, light yellowish, without mica; it forms thick banks, and may be seen in perpendicular cliffs forty-five to fifty miles below St. Louis, near Prairie du Rocher in Illinois, where its strata show a southerly dip. In its upper part, or rather between it and the St. Louis limestone, occurs the lowest bed of coal. It may be seen in Prairie du Long, 40 miles southeast of St. Louis, in Illinois, where a small stream, the Richland creek, which higher up, near Belleville, has denuded the workable upper coal bed and the overlying limestone, expo-

ses after cutting through the St. Louis limestone, this seam of one to two feet thickness; it then enters the sandstone, which here is not as thick as at Prairie du Rocher, and at last exposes the lower carboniferous limestone strata with their peculiar fossils. This sandstone may have a thickness of from fifty to a hundred feet. It rests on the lower limestone formation, which is of much greater thickness than the upper one and is probably near a thousand feet thick, at least where the Mississippi cuts through it from twenty to sixty miles below St. Louis. This lower carboniferous limestone is mostly of a gray color, often bituminous, and mostly crystalline in texture. In some strata it is more or less oolitic, and the large banks of the beautiful white oolite near St. Geneviève, which is worked there and is frequently sent down the river, are in the lower part of this formation. Only the lower carboniferous limestone contains the beautiful pentremites so common in that part of Illinois, and the Archimedes found there and on the lower Ohio. The pentremital limestone of Dr. Owen is therefore the lower part of the carboniferous limestone of eastern Missouri and southern Illinois, and our St. Louis limestone is its upper part.

Dr. H. King, who has seen this formation in the southwestern parts of Missouri, thinks that on the Osage river, this lower limestone formation dwindles very much; but that the sandstone and coal stratum above it is much more developed, and that the fine coal mines worked there, sometimes not far above and distinct from the lead-bearing magnesian strata, are in this same lowest coal bed.

7. *Cause of the absence of Ancient Marine Formations from certain regions;* by CHARLES DARWIN, (Geological Observations on South America, p. 136.)—Can any light be thrown on this remarkable absence of recent conchiferous deposits on these coasts, on which, at an ancient tertiary epoch, strata abounding with organic remains were extensively accumulated? I think there can, namely, by considering the conditions necessary for the preservation of a formation to a distant age. Looking to the enormous amount of denudation which on all sides of us has been effected,—as evidenced by the lofty cliffs cutting off, on so many coasts, horizontal and once far extended strata of no great antiquity (as in the case of Patagonia),—as evinced by the level surface of the ground on both sides of great faults and dislocations, by inland lines of escarpments, by outliers, and numberless other facts, and by that argument of high generality advanced by Mr. Lyell, namely, that every *sedimentary* formation, whatever its thickness may be, and over however many hundred square miles it may extend, is the result and the measure of an equal amount of wear and tear of preëxisting formations; considering these facts, we must conclude that, as an ordinary rule, a formation to resist such vast destroying powers, and to last to a distant epoch, must be of wide extent, and either in itself, or together with superincumbent strata, be of great thickness. In this discussion, we are considering only formations containing the remains of marine animals, which, as before mentioned, live, with some exceptions, within (most of them much within) depths of a hundred fathoms. How, then, can a thick and widely extended formation be accumulated, which shall include such organic remains? First, let us take the case of the bed of the sea long remaining at a stationary level: under these circumstances, it is evident that *conchiferous* strata can accumulate only to the same thickness with the depth at

which the shells can live; on gently inclined coasts alone can they accumulate to any considerable width; and from the want of superincumbent pressure, it is probable that the sedimentary matter will seldom be much consolidated: such formations have no very good chance, when in the course of time they are upraised, of long resisting the powers of denudation. The chance will be less if the submarine surface, instead of having remained stationary, shall have gone on slowly rising during the deposition of the strata, for in this case their total thickness must be less, and each part, before being consolidated or thickly covered up by superincumbent matter, will have had successively to pass through the ordeal of the beach; and on most coasts, the waves on the beach tend to wear down and disperse every object exposed to their action. Now, both on the south-eastern and western shores of South America, we have had clear proofs that the land has been slowly rising, and in the long lines of lofty cliffs, we have seen that the tendency of the sea is almost every where to eat into the land. Considering these facts, it ceases, I think, to be surprising, that extensive recent conchiferous deposits are entirely absent on the southern and western shores of America.

Let us take the one remaining case, of the bed of the sea slowly subsiding during a length of time, whilst sediment has gone on being deposited. It is evident that strata might thus accumulate to any thickness, each stratum being deposited in shallow water, and consequently abounding with those shells which cannot live at great depths: the pressure, also, I may observe, of each fresh bed would aid in consolidating all the lower ones. Even on a rather steep coast, though such must ever be unfavorable to widely extended deposits, the formations would always tend to increase in breadth from the water encroaching on the land. Hence we may admit that periods of slow subsidence will commonly be most favorable to the accumulation of *conchiferous* deposits, of sufficient thickness, extension, and hardness, to resist the average powers of denudation.

## III. Botany and Zoology.

1. *Hillocks of Bolax glebaria, of the Falkland Islands*, (extract from J. D. Hooker's Flora Antarctica.)—"Long before the Falkland Islands were colonized from Britain, the present plant had excited considerable curiosity by the very remarkable mode of growth it there assumes, and its forming a feature in the landscape that strikes the most casual observer. Now that these islands have been annexed formally to the British dominions, the *Bolax* or *Balsam-bog*, is a production of still greater general interest. In whatever portion of this country the voyager may land, he cannot proceed far along the beach without entering groves of Tussac, whose leaves often wave over his head; nor turn his steps inland, without seeing, scattered over the ground, huge, perfectly hemispherical hillocks of a pale and dirty yellow green color, and uniform surface, so hard that one may break the knuckles on them. If the day be warm, a faint aromatic smell is perceived in their neighborhood, and drops or tears of a viscid white gum flow from various parts of these vegetable hillocks. They stand apart from one another, varying from two to four feet in height, and though often hemispherical, are at times much broader than high, and even eight or ten feet long.

"The very old ones begin to decay near the ground, where a crumbling away commences all around, and having but a narrow attachment, they resemble immense balls or spheres laid upon the earth. Upon close examination, each mass is found to be herbaceous throughout, the outer coat formed of innumerable little shoots rising to the same height, covered with imbricating leaves, and so densely packed that it is even difficult to cut out a portion with a knife, while the surface is of such uniformity that lichens sometimes spread over it, and other plants vegetate on its surface, in the occasional holes or decayed places. If at a very early period, a young plant of the *Bolax* be removed and examined, the origin of these great balls may be traced; for each of them, of whatever size, is the product of a single seed, and the result of many, perhaps of hundreds of years' growth. In a young state, the plant consists of a very long slender perpendicular root, like a whip lash, that penetrates the soil. At its summit are borne two or three small branching stems, each densely covered for its whole length with sheathing leaves. As the individual increases in size, the branches divide more and more, radiating regularly from the rooting centre, instead of prolonging rapidly; these send out lateral short shoots from their apices and in such numbers that the mass is rendered very dense, and by the time the plant has gained the diameter of a foot, it is quite smooth and convex on the surface. The solitary root has become evidently insufficient for the wants of the mass of individuals, which are nourished by fibrous radicles, proceeding from below the leaves, and deriving nutriment from the quantity of vegetable matter which the decayed foliage of the lower part of the stems and older branches affords."—p. 286.

2. *On the Vertebrate Structure of the Skull;* by Prof. Owen, (Brit. Assoc., from the Athen., Sept. 26, 1846.)—Prof. Owen commenced by referring to his previous definition of a typical vertebra, or primary segment of the endo-skeleton (Ath. No. 986, p. 969). He considered that the bones of the skull consisted of a series of four such segments;—but before entering into the details on which his conclusions were founded, he reviewed the previous classifications of the cranial bones from the early anthropotomical one into those of the *cranium* proper and those of the *face*, to the latest classification by M. Agassiz, based upon the embryological researches of Dr. Vogt. With regard to the division into bones of the cranium and those of the face, he observed that this having been originally founded upon the exclusive study of the most extremely modified skull in the whole vertebrate series,—that of man, the characters of such primary divisions were artificial, and applicable to the same bones in only a small proportion of vertebrata. Thus the facial series in fishes includes an extensive system of bones—the lugoid—of which part only, viz., the "styloid" element, is admitted into the skull by the anthropotomist, who describes it as a process of the temporal bone;—his "temporal" bone being, as Prof. Owen showed in his previous communication [Ath. p. 988], originally and essentially an assemblage of bones, which are always distinct in fishes and reptiles, and all of which appertain to distinct natural systems of groups of bones, though so strangely blended for a special object into one osseous mass in the human subject. The petrous process (petrosal) is the spinal capsule of the acoustic organ; the mastoid

process is the transverse process (parapophysis) of the parietal vertebra: the styloid process is the proximal piece (pleurapophysis) of the hyoid arch; the tympanic or external auditory process is the modified proximal element of the mandibular arch; the squamous process (squamosal) is a diverging appendage of the maxillary arch. Amongst the bones of the head might be recognized in most vertebrate animals some belonging to the system of the splanchno-skeleton, and some to the dermo-skeleton; those of the endo-skeleton constituting the chief and most important part of the skull, Prof. Owen believed, with Ohm and Bajanus, to be naturally arranged in a series of segments, each consisting of an upper (neural) and a lower (hœmal) arch, with a common centre, and usually with diverging appendages. The bones entering into the composition of each segment had, in fact, the same relative position, and were similar in number with those of the typical vertebræ of the trunk—the excess in number arising from subdivision of peripheral elements; he should, therefore, continue to apply the name vertebra to these segments. Homologists differed as to the number of cranial vertebræ; and the skull might differ, like the neck, the back, and other regions, in different animals, as to the number of its vertebral segments, but Prof. Owen had not seen good evidence of a greater or less number than four, in which he agreed with Bajanus. He enumerated these segments in a direction contrary to those of the trunk, because, like the vertebræ of the tail, they lose their typical character as they recede from the trunk: the chief condition of these terminal modifications being the circumstance of the contained nervous axis shrinking and receding centripetally at both its ends. He retained for the cranial vertebræ the names applied to them, in conformity with those given by the anthropotomist to their neural spines, viz., *occipital*, *parietal*, *montal*, *nasal*; the upper or neural arches of each he termed, respectively, *epencephalic*, *mesencephalic*, *prosencephalic*, and *rhinencephalic*; the lower or hæmal arches were the *scapular*, the *hyoidean* the *mandibular*, the *maxillary*; the diverging appendages of these hæmal arches are, respectively, the *pectoral*, the *branchiostegal*, the *opercular* and the *pterygoid*; the maxillary arch likewise supporting, in higher vertebrata, a *zygomatic* appendage, for its more complete fixation. The special homology of the pectoral fins of fishes with the fore-limbs of quadrupeds was indicated by Aristotle, and first definitely pointed out, in later times, by Artedi. Geoffroy St. Hilaire had devoted special memoirs to the determination of the bones of the pectoral fins; but had no knowledge of the primary homology of the pectoral fin as the radiated appendage of the inferior arch of a cranial vertebra, or of its serial homology with the branchiostegal and opercular fins. He consequently spoke of the junction of the scapular arch to the cranium as something very strange. Ohm's latest published idea of the essential nature of the arms and legs is, that they are no other than "liberated ribs." Carus, in his ingenious endeavours to gain a view of the primary homologies of the locomotive members, sees in their several joints repetitions of vertebral bodies—vertebræ of the third degree. But Prof. Owen remarked, that such transcendental analyses sublimated all differences, and definite knowledge escaped through the unwarrantable extension of the meaning of terms. He re-

cognized a vertebra as a natural group of bones forming a primary segment of the skeleton; in each segment he also recognized a centrum, a neural arch, a hæmal arch, with sometimes diverging appendages: each of these were parts of a vertebra, and each different parts; to call them all "vertebræ" was to abdicate the powers of appreciating and expressing their differential and subordinate characters. With regard to the term "rib," though it might be given to each moiety of the hæmal arch of a vertebra, Prof. Owen would restrict it to that part of such arch to which the term "vertebral rib" is commonly applied; but, admitting the wider application, yet the bony diverging and backward projecting appendage of such rib or arch was a different thing from the part supporting it. Arms and legs might be developments of costal appendages, but were not the ribs themselves liberated,—although liberated ribs might perform analogous functions, as in the serpents and draco volans.

3. *Remarks on the Melonites multipora;* by G. ENGELMANN, M. D., (communicated for this Journal.)—On a single slab of limestone about four square feet in size, in the possession of the Western Academy of Natural Science of St. Louis, there are fifteen specimens of the Melonites, described in the last number of the American Journal of Science. The slab was presented to the Academy by Dr. B. B. Brown in the year 1841. Dr. B., undoubtedly the first scientific gentleman who saw this fossil, found the slab with several others similar on a heap of building stones. Other specimens were presented by him to the Academy of Natural Science of Philadelphia, to Mr. J. Hall of New York, and others. He could not ascertain the precise locality where these stones were obtained, but is under the impression that they came from one of the quarries near the river bank. I have for years examined all the quarries in and about St. Louis, without meeting with even a trace of this fossil, except in some situated northwest of the town, more than a hundred feet above the Mississippi, where single scutellæ, which it is impossible not to recognize, are common in some strata, together with corallines, joints of encrinital stems, a few shells, and spines very similar to those of a true Echinus.

The specimens of Melonites before me are all flattened, but present different views, either one side or an upper or lower end, so that it is not difficult to reconstruct the animal. It would appear that it was not completely spheroidal or ovoid, but rather somewhat of the shape of the Pentremites; thicker at the lower than at the upper end, but suddenly somewhat contracted. I can well distinguish the two ends. What I take to be the lower end, shows both kinds of areæ of equal width, and the different plates are so closely connected that they cannot be any longer distinguished. At the upper end the *areæ majores* run out quite narrow, and the *areæ ambulacrorum* are wider; the plates are all small there, and in many specimens distinctly separated. I could see nothing of the oral or anal openings, except the deep impression at both ends of the animal.

The *areæ majores* are composed of five to seven or rarely eight rows of mostly hexagonal, more or less regular plates, those in the middle being transversely elongated. The *areæ ambulacrorum* are not much narrower than the others, and as I have already said, become even wider than them near the upper end. They have, as Drs. Norwood and Owen have correctly remarked, two vertical rows of larger hexagonal plates in the middle,

which constitute a prominent vertical ridge, on the summit of which they interlock, forming a serrated suture. The other plates of the *areæ ambulacrorum* are much smaller, of more irregular shape and disposition, but always, like all the other plates, are more or less *hexagonal. All the plates* of the *areæ ambulacrorum* are pierced by two holes, side by side, and *all* of them—not only those of the two larger central rows—very decidedly near the *outer* angle, or that angle farthest from the central ridge. These holes are placed irregularly; and generally I can only distinguish an inner vertical row of double pores, (those of the larger central plates,) and an outer one, next to the *areæ majores;* all the other pairs of pores are distributed more irregularly over the surface, and it is with difficulty that I can make out something like four or five rows on each side of the middle ridge, which dwindle down to two or three rows towards the ends.

The specimens are from three to five inches in vertical diameter, and very little less in the transverse. No trace of a stem has been found near them.*

4. *Hippopotamus at Sierra Leone.*—T. P. Thompson, Esq., in a letter to J. E. Gray, Esq., mentions the existence of a small Hippopotamus at Sierra Leone, which, as Mr. Gray states, is a fact of peculiar interest, since a new species from Liberia, of corresponding size, has been described by Dr. S. G. Morton. (See Proc. Acad. Nat. Sci. Phil., Feb., 1844, and this Journal, xlvii, 406.)

5. *Tracks of Alligators;* (Proc. Acad. Nat. Sci. Philad.)—Dr. Dickeson exhibited to the Academy at Philadelphia, at a meeting in October last, impressions of the feet of living alligators on clay, which resembled closely in form the so-called bird tracks.

6. *Wings of Locustæ;* (Proc. Acad. Nat. Sci. Phil., iii, No. 5.)—From the microscopic examinations of J. Leidy, it is shown that the wings of locusts, (which when at rest are folded up like a fan,) are closed by spiral ligaments, one of which winds around each of the transverse veins. They act by their own physical properties alone, on the relaxation of the muscles which open the wing.

7. *Harlanus, a new genus of fossil Pachyderms;* (Proc. Acad. Nat. Sci. Philad. Aug. 1846.)—Richard Owen, Esq., has instituted the genus Harlanus for the species called *Sus americanus* by Harlan. It is described as approaching most nearly the tapiroid Pachyderms. The species is named by Mr. Owen, Harlanus americanus.

## IV. Astronomy.

1. *Observations on Shooting Stars, August* 10, 1846.—During the nights of August 8–9th and 9–10th, 1846, the sky at this place was overcast. The sky remained cloudy on the evening of the 10th, but nevertheless, the observers (Messrs. L. W. Hart, J. H. Lane, W. Manl. Smith, and myself) sat up, in the hope of more favorable weather during the night. Not long before midnight the clouds passed off. Taking our station in the open air, we watched from $0^h$ A. M. to $2^h$ A. M. of the 11th, and observed shooting stars as follows:—

| | N. E. | S. E. | S. W. | N. W. | |
|---|---|---|---|---|---|
| Aug. 11, $0^h$ A. M.—1 A. M. | 5 | 1 | 2 | 6 | =14 |
| " 1 A. M.—2 A. M. | 9 | 9 | 9 | 5 | =32 |

* An account of the St. Louis rocks, by Dr. Engelmann, will be found on p. 120.

The encouragement for further observation seemed so small, and the presence of the moon was so embarrassing, that we retired at the end of the second hour.

The evening of the 11th was beautifully clear. Mr. Francis Bradley and myself observed from $9^h$ to $10^h$ P. M., and saw in the hour *forty-one* different shooting stars, viz. 18 in the N. W. and 23 in the S. E. The moon did not rise until about half an hour after nine, and of course interfered but little. Many of these meteors were brilliant, and in their direction and general character were similar to those heretofore observed at this period. It is perhaps worthy of mention, that the Aurora Borealis (which had not been seen here with certainty since the 14th of June previous,) was visible on the evenings of the 11th and 12th. These displays were slight; the streamers few in number, not reaching an altitude of more than 4°.

The observations of the morning of the 11th, (even supposing that the moon-light obscured half of the meteors,) appear to indicate but a slight recurrence of the exhibition usual at this period. The results of the evening of the 11th seem however to justify the inference that the display did not fail this year; and perhaps, in favorable circumstances, we might have seen the meteors nearly as abundant as on former anniversaries.

In regard to the November meteoric period, it may be stated that the clouds here permitted no observation on the mornings of the 12th, 13th, or 14th, in 1846. A faint Aurora Borealis was seen here during the evening of the 11th of that month. A writer in the *Albany Evening Journal* states that on the morning of November 20, meteors were unusually numerous. A communication signed B., in "*The News*" of Jacksonville, Florida, (of Nov. 13, 1846,) alleges that on the morning of Oct. 20th, 1846, numerous shooting stars were seen and explosions heard. As no numbers are given in either case, it is not easy to decide how remarkable these displays really were. E. C. H.

New Haven, Conn.

2. *Ancient returns of Halley's Comet.*—In a paper read May 8, 1843, to the French Academy of Sciences, (*Comptes Rendus*, xvi, 1003,) M. Laugier announced that among the notices of comets, extracted by M. Edouard Biot, from Chinese historians, (and communicated to the *Bureau des Longitudes*,) were observations in 1456, and also in 1378, of a body which was undoubtedly the comet of Halley.

Laugier gives the following elements for 1378, which very well represent the Chinese observations.

| | | |
|---|---|---|
| Perihelion passage, A. D. 1378, Nov. 8·77. | | |
| " distance, | 0·5835. | |
| Inclination, | 17° 56′. | |
| Longitude of ascending node, | 47 17 | Equin. of 1378. |
| " " perihelion, | 299 31 | |
| Motion, | Retrograde. | |

He adds the following table of the comet's revolutions.

| | | |
|---|---|---|
| 1378 to 1456 | - - | 77·58 years. |
| 1456 " 1531 | - - | 75·21 " |
| 1531 " 1607 | - - | 76·15 " |
| 1607 " 1682 | - - | 74·91 " |
| 1682 " 1759 | - - | 76·49 " |
| 1759 " 1835 | - - | 76·68 " |

In a communication made July 27, 1846, (*Com. Ren.*, xxiii, 183,) Laugier announces as a result of further investigations among Biot's extracts, the discovery of three earlier returns of this comet, viz: (1.) A. D. 1152, perihelion passage, Sept. 23, giving to 1378, three revolutions of 75·3 years. (2.) A. D. 760, per. pas. June 11, giving to 1378, eight revolutions of 77·25 years. (3.) A. D. 451, per. pas. July 3·5, giving to 1378, twelve revolutions of 77·25 years. In addition to the usually recognized perturbing causes, which may have operated in producing this change of period, he suggests the possible diminution of the comet. On the supposition that this body has lost, in certain given conditions, as much as the 23000th part of its mass, a quantity not very extraordinary. Bessel found that the period of revolution would be diminished 1107 days.

3. *Prof. Peirce's Catalogue of Comets.*—The American Almanac for 1847, (Boston, pp. 352, 12mo,—the 18th No. of a series well known as furnishing, together with much other important matter, the most reliable statistics of our country,) comprises a very valuable catalogue, by Prof. Peirce of Harvard University, of the comets whose orbits have been computed. The catalogue by Rev. Mr. Hussey, intended to include every comet, whether the elements of its orbit were known or unknown, (*Lond. and Edin. Phil. Mag.*, vols. ii, iv, vii,) appears not to have been continued later than the year 1744. The catalogue by Olbers and Schumacher, (republished from Schumacher's *Astronomische Abhandlungen*, in the *Quar. Jour. Sci. Lit. and Arts of Roy. Inst.*, Lond. vols. 16, 17, 20,) ended with May, 1825. Since that time, the investigations of astronomers have determined the elements of several comets previously observed, and have made more exact the elements of others already enrolled. To collect and arrange these, adding all those discovered up to the present time, was a work much needed, and Prof. Peirce has rendered an important service to astronomy, by executing the task.

His catalogue comprises I, a *chronological arrangement* of the elements; the longitudes of the ascending node and the perihelion being referred to the mean equinox of Jan. 1, 1850; and II, a *systematic arrangement*, in which the elements are grouped in twelve tables, with reference to the longitude of the ascending node. Each table has four subdivisions (none comprising more than eleven comets) in each of which "are given all those orbits which properly belong to it, and also those which have, or may have, any resemblance to them; so that in order to compare a new orbit with the old ones, it is only necessary to inspect that subdivision to which the new orbit would properly belong; that is, to look into that table which has the same name as the sign of the ascending node of the new orbit, and into the first, second, third or fourth subdivision of the table as the inclination may be in the first, second, third or fourth octant." This plan of classification greatly abridges the labor of determining whether any newly-discovered comet is identical with any of those already known.

Prof. Peirce's catalogue contains five comets whose elements have not been hitherto published, but are by himself computed from ancient observations, with such precision as they may warrant, viz: B. C. 137, 69, 12, and A. D. 1366 and 1491. The following orbits (most of them recently published,) are not found in the catalogue, and are perhaps worthy of a place therein, although they are confessedly somewhat uncertain, on account of the looseness of the observations upon which they are founded.

The longitudes of the perihelion and node are not reduced to 1850, but belong to the mean equinox of their respective years.

| Date of Perih. pas. Gr. m. t. | Long. asc. node | Long. perih. | Incl. | Perih. dist. | Motion. | Computer and time. |
|---|---|---|---|---|---|---|
| A. D. 770. June 6·6. | 89° | 2° | 60° | 0·603 | R. | Hind. Dec. 1845. |
| 962. Dec. 30·16. | 350 35′ | 268 3′ | 79 33′ | 0·5518 | R. | Hind. Jan. 1846. |
| H. 1378. Nov. 8·76. | 47 17 | 299 31 | 17 56 | 0·5835 | R. | Laugier. May 1843. |
| 1468. Oct. 7·41. | 61 15 | 356 3 | 44 19 | 0·85328 | R. | Laugier. Jan. 1846. |
| * 1490. Dec. 24·47. | 288 45 | 58 40 | 51 37 | 0·7376 | D. | Hind. Jan. 1846. |
| 1596. Sept. 3·662. | 132 50 | 250 37 | 45 1 | 0·38598 | R. | Laugier. Jan. 1846. |
| 1668. Feb. 28·8. | 357 17 | 277 2 | 35 58 | 0·004786 | R. | Henderson. Apr. 1843. |

Prof. Peirce's catalogue contains 174 comets, reckoning that of April, 1556, as identical with that of July, 1264, and that of Aug. 13, 1770, as identical with that of October, 1585; and omitting in the enumeration the three comets which have returned agreeable to computation, viz: those of Halley, Encke and Biela. If we add these four, (the latter having become double,) and also include five of those above given, and that of May 14, 1846, (discovered too recently for insertion,) we have, down to the middle of 1846, 184 different comets whose elements are determined with more or less certainty. The whole number of which we have any record is about 600.

4. *Le Verrier's Planet.*—In our last number (vol. ii, p. 439) was announced the discovery of the planet beyond Uranus, in accordance with the predictions of Le Verrier. This discovery must be considered one of the most remarkable recorded in the annals of science, and elevates Le Verrier to the first rank among astronomers. Of its history, we have room at present only for the following brief sketch.

Omitting to cite various notices which indicate that for several years past there has been among astronomers a growing suspicion of the existence of some unknown body in our system, by which the motions of Uranus is disturbed, we may quote the following as one evidence.

In the Comptes Rendus Acad. Sci., (Session Sept. 1, 1845,) xxi, 524, is an extract from the preface to *New Tables of Uranus*, by Eugene Bouvard, communicated to the Academy, in which, after speaking of the impractibility of reconciling, by any existing theory, the computed and the observed places of this planet, he adds: "the discordances between the observations and the theory induce me to believe that there is much probability in the idea proposed by my uncle, (Alexis Bouvard, whose tables of Uranus, &c., were printed in 1821,) as to the existence of another planet, disturbing Uranus. This opinion, moreover, is further strengthened by the analogy which appears in the periodicity of these discordances, and those which Saturn would present if we should suppose Uranus unknown."

At the session of Nov. 10, 1845, (Comp. Ren., xxi, 1050,) Mons. U. J. Le Verrier presented his *First Memoir on the Theory of Uranus.* Having alluded to the discrepancies between the observed and computed places, he says, "in the course of the last year, M. Arago represented to me that the importance of this question made it the duty of every astronomer to do his best to clear it up. I abandoned at once, in order to investigate Uranus, the researches on comets which I had undertaken, and of which several portions have already been communicated. Such is the

* This may be the same as Prof. Peirce's No. 28; yet the orbits differ widely.

origin of the work which I have the honor to day to present to the Academy." He proceeds to state in general his investigations of all the known perturbing causes operating on Uranus, and his determination of the actual amount of departure of Uranus from the places assigned by the theory.

In his second communication to the Academy, (at the session of June 1, 1846,) Le Verrier presents a history of the observations upon Uranus, and of the mode in which the tables of its motions have been constructed, and the errors which they involve; and a sketch of various hypotheses proposed to account for the inequalities of the motions of the planet. Having set these aside, he asks—*Is the other hypothesis of the existence of an unknown planet disturbing Uranus, more plausible?* After showing where this new planet cannot be situated, he arrives at this question—"Is it possible that the inequalities of Uranus are due to the action of a planet situated in the Ecliptic, at a mean distance double that of Uranus? And if so, where is this planet actually situated? What are the elements of the orbit which it traverses?" As one result of a rigorous discussion of this question, he gives, as a first approximation, this momentous conclusion, *that in assigning to the planet a heliocentric longitude of* 325° *for Jan.* 1, 1847, *there cannot be an error of* 10°. This assigned place he then promises to bring within narrower limits, by new computations. In recapitulating the labors required by his undertaking, he adds—"The existence of a planet hitherto unknown being thus established beyond a doubt, I have reversed the problem hitherto proposed in computing perturbations. Instead of measuring the action of a given planet, I have been obliged to set out from the inequalities observed in Uranus, in order to deduce the elements of the disturbing body, to give the place of this planet in the heavens, and to show that its action perfectly accounts for all the apparent inequalities of Uranus."

This remarkable prediction of the position of a planet hitherto entirely unknown, uttered with calm confidence by the mathematician in his closet, seems to have been received with faint faith even by the astronomical observers of Paris. For it is evident that the observer furnished with a good map of that region of the Ecliptic, which might have been made in a few hours from star-catalogues, would have quickly detected a bright star not laid down. With a large telescope and a high power, this stranger would have presented a plain disc, and would thus have instantly disclosed its true character. Or if, with a smaller instrument, its place had been carefully measured, the observation of the next morning would have shown its proper motion.

On the 31st of August, 1846, Le Verrier, with implicit reliance on the truth of his computation, presents to the Academy, a memoir "ON THE PLANET WHICH CAUSES THE ANOMALIES IN THE MOVEMENT OF URANUS," *with a determination of its mass, its orbit and its actual position,* (Comp. Ren., xxiii, 428.) In this paper he gives the elements at which he had arrived, as follows:

| | | |
|---|---|---|
| Semi-axis major of the orbit, | 36·154 | |
| Period of sidereal revolution, | 217$^{yrs}$·387 | |
| Excentricity, | 0·10761 | |
| Long. of perihelion, | 284° 45′ | M. Eqx. 1847·0 |
| Mean long. Jan. 1, 1847, | 318 47 | |
| Mass, | $\frac{1}{9300}$ | |

From which he derives the following position of the planet, Jan. 1, 1847.

| | |
|---|---|
| True heliocentric longitude, | 326° 32′ |
| Distance from the Sun, | 33·06, |

and remarks that the planet was in opposition August 19th previous, and that the present was a favorable time to discover the body.

The semi-axis major might vary from 35·04 to 37·90, and the period from 207 to 233 sidereal years. The brilliancy of the planet ought to be about one third that of Uranus at its mean distance, and its angular diameter at opposition 3″·3.

The action of the new planet, with elements as above determined, reconciles with theory, within very narrow limits, the observations of Uranus, both modern and ancient.

Even this memoir seems not to have overcome the incredulity or the indifference of astronomical observers, for it appears hardly possible that search could then have been made in the place pointed out by Le Verrier, without immediate success.

On the 5th of October, (Comp. Ren., xxiii, 657,) Le Verrier presented the fifth and last part of his researches, in which he gives his reasons for concluding that the plane of the orbit of the new planet is inclined at least 4° 38′ to the plane of the orbit of Uranus. In a postscript, he adds, that on the 18th of September, he addressed a letter to M. Galle of Berlin, asking his aid in discovering the planet, and that this astronomer discovered the body on the very day on which the letter reached him. Its observed place Sept. 23, $12^h\ 0^m\ 14^s$, Berlin m. t., was R. A. 328° 19′ 16″ and S. dec. 13° 24′ 8″·2; only 52′ from the place assigned by Le Verrier. M. Galle was furnished with the Berlin Academy Star-map of the 21st hour, (by Bremiker,) then just published, yet other astronomers could with very little labor have made for themselves from the star-catalogues, charts abundantly sufficient for the detection of a new body of such brilliancy. The whole history of the affair evinces much distrust or apathy on the part of the astronomical observers, and undoubting confidence on the part of the mathematician,—confidence which the event has most fully justified.

The annals of science show that a discovery has often been made about the same time in different countries, and by persons unconscious of each other's labors. The present case offers another instance of this nature. In the Lond. Edin. and Dub. Phil. Mag., Vol. xxix, No. 197, Suppl. No., Dec., 1846, G. B. Airy, Esq., the Astronomer Royal, has published numerous letters and other documents, (most of which had already appeared in the London Athenæum of Oct. 3, 17, 31, and Nov. 28, 1846,) proving that Mr. J. C. Adams, of St. John's College, Cambridge, undertook, as long ago as 1843, an investigation of the anomalies of Uranus. As a result of his labors, he left, on one of the last days of October, 1845, at the Royal Observatory, Greenwich, a paper of which the following is an extract:—

"According to my calculations, the observed irregularities in the motion of Uranus may be accounted for by supposing the existence of an exterior planet, the mass and orbit of which are as follows:—

| | |
|---|---|
| Mean distance, (assumed nearly in accordance with Bode's law,) | 38·4 |
| Mean sidereal motion in 365 25 days, | 1° 30′·9 |
| Mean longitude, Oct. 1, 1845, | 323° 34′ |
| Longitude of perihelion, | 315° 55′ |
| Excentricity, | 0·1610 |
| Mass, | 0·0001656." |

If the English astronomers had now searched the Ecliptic, through but a few degrees on each side of the point here indicated by Mr. Adams, they would, with clear weather, undoubtedly have discovered the new planet within a week. That they did not do this, must probably be attributed to a want of confidence in the computation. Or if Mr. Adams's note had then been printed, he would have secured the glory which is now, according to the recognized rule, due to M. Le Verrier. So easily is a glorious opportunity lost forever!

The coincidence between the position for the planet assigned in Le Verrier's paper of June 1, 1846, and that which Mr. Adams had given, was so remarkable, that Prof. Challis undertook to search for the body, with the aid of the Northumberland telescope of the Cambridge Observatory, one of the largest refractors in the world. He commenced his sweeps July 29, 1846, and between this date and the time of the arrival of the news of the discovery at Berlin, he actually secured two observations of the planet, but without recognizing them until then. These places are

| | R. A. | N. P. D. |
|---|---|---|
| 1846, Aug., $4^d$ $13^h$ $36^m$ 25 | $21^h$ $58^m$ $14^s{\cdot}70$ | 102 57 32·2 |
| 12 13 3 26 | 21 57 26·13 | 103 2 0·2 |

In a letter to Mr. Airy, dated Sept. 2, 1846, Mr. Adams gave results somewhat different from those communicated in October, 1845; the difference being due to the assumption of a mean distance about one-thirtieth less. He suggested, moreover, that "by still farther diminishing the distance, the agreement between the theory and the late observations might be rendered complete, and the eccentricity reduced at the same time to a very small quantity."

The new planet has doubtless been seen at all the observatories in this country, and may be easily detected by a good spy-glass. In the *Sidereal Messenger*, Vol. i, No. 6, Prof. Mitchel, the director of the Cincinnati Observatory, has given an interesting account of his first observation upon the body with the large refractor. Having received, Oct. 28th, the news of the discovery, he directed the telescope, soon after 6 P. M., to the region of the heavens occupied by the planet, taking his place at the finder, the assistant being seated at the large telescope. "The planet was described as a star of the 8th magnitude. On placing my eye to the finder, four stars of this magnitude were seen. The first was brought to the centre of the field of view of the Equatorial, and after examination by my assistant was rejected—a second was examined critically, and in like manner rejected. The third star, a little smaller and whiter than the other two, was now brought into the field of view, and instantly I heard the exclamation from my assistant—'There it is! there's the planet! with a disc round, clear, and beautiful as that of Jupiter!' My own eye was now placed to the eye piece of the great refractor, and to my unspeakable pleasure, I found a beautiful disc, so well defined, that without any knowledge of a previous discovery, it never would have been passed over for a moment." Prof. Mitchel immediately proceeded to measure the diameter of the disc, six measures being made by his assistant, and six by himself; the mean of the whole gave 2″·523. This is somewhat less than the result given by Schumacher. The real diameter of the planet is probably more than 40,000 miles.

The name of the new planet seems not yet quite determined. The mythological designations of *Janus*, *Oceanus*, *Neptunus*, *Atlas*, &c. have been proposed. M. Le Verrier, to whom the right of imposing the name undoubtedly belongs, has delegated this right to M. Arago. The latter declares that it ought to bear the name of its illustrious discoverer, and denominates it *Le Verrier*. It seems unwise thus to depart from the received system of nomenclature; as *Uranus* and the five small planets must then change their titles; and it is also quite possible that the names of future discoverers may be either unpleasantly short or immoderately long, or otherwise unsuited for this celestial use.

5. *New Comets.*—A comet was discovered (Com. Ren., Oct. 5, 1846) in *Ursa Major*, by De Vico at Rome, about 8 P. M., Sept. 23, 1846. Its R. A. and N. decl. were diminishing. Its approximate place, Sept. 23, $10^h\ 11^m\ 29^s$, was, R. A. $23^m\ 6^s$ less than *tau Ursæ majoris*, and N. declination 7′ greater.

A telescopic comet was detected (Lond. Athenæum, Oct. 24, 1846) in the constellation *Coma Berenices*, by Mr. J. R. Hind, London, about 4 A. M., Oct. 19, 1846. It was a faint nebulosity, 2′ or 3′ in diameter, with a central bright spot. Daily motion, in R. A. about $3^m\ 12^s$ increasing; decl. diminishing 12′. The following are two positions obtained by comparison with *Beta Leonis*.

| | R. A. | N. Decl. |
|---|---|---|
| Oct. 18, $16^h\ 15^m\ 11^s$, Gr. m. t. | 11 59 49·1 | 14 59 32 |
| 17 2 23 | 11 59 57·5 | 14 59 8 |

It is supposed to be a different body from that discovered by De Vico, Sept. 23.

## V. Miscellaneous Intelligence.

1. *Smithsonian Institution.*—As this Institution is now taking on a definite form, under the law of Congress approved Aug. 10, 1846, it may be desirable to give an outline of its leading features, and to designate the valuable objects which we trust will be accomplished under it. It will be remembered that James Smithson, Esq., of London, gave his whole property to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men. The sum of *money* paid into the United States Treasury under this bill, was $515,169, which has been on interest at 6 per cent. since September 1st, 1838, yielding, on the 1st of July, 1847, the additional sum of $242,129.

By the bill, the President, Vice President, Secretary of State, Secretary of the Treasury, Secretary of War, Secretary of the Navy, the Postmaster General, the Attorney General, the Chief Justice, and Commissioner of Patents of the United States, and the Mayor of Washington, are, for their respective terms of office, constituted an "establishment," by the name of the "Smithsonian Institution." They have perpetual succession, and power to choose certain other persons as honorary members. The business of the Institution is to be controlled by a "Board of Regents," who are the Vice President and Chief Justice of the United States, Mayor of the city of Washington, during the terms of office, three members of the United States Senate, and three members of the House of Representatives, together with six other persons, other than members

of Congress, two of whom shall be members of the National Institute, in the city of Washington, and resident in the said city, and four others, inhabitants of States, and no two of them in the same State. In our Nov. No. (vol. ii, p. 440,) we gave the list of these officers as chosen according to law, last September. The Board of Regents have power to elect one of their own number as "Chancellor," a "suitable person" as Secretary, and three of their own body as an Executive Committee. It is provided that the Board shall at once cause to be erected, out of the accumulated interest of the fund, a suitable building of sufficient size, and with proper rooms or halls for the reception and arrangement, upon a liberal scale, of objects in all departments of natural history, a chemical laboratory, a library, a gallery of art, and the necessary lecture rooms. All objects of art, and of foreign and curious research, and all objects of natural history, plants, and geological and mineralogical specimens, belonging, or hereafter to belong to the United States, which may be in the city of Washington, are to be placed under the control of the Institution.

The duties of the Secretary of the Board of Regents, are to take charge of the building and property of the Institution, keep its records, and act as Librarian, and keeper of the museum. To aid him in discharging those numerous and important duties, he is permitted to employ assistants. The current expenses of the Institution are to be paid out of the annual income of the foundation, which will be over $30,000. Of this sum the Regents are authorized to appropriate not exceeding an average of $25,000 annually, for the gradual formation of a library, composed of valuable works pertaining to all departments of human knowledge. To aid in this most important work, the bill provides that the owner of every copyright work in the United States, shall within three months after its publication, deposit one copy of it in the library of the Institution, and also one copy in the library of Congress.

Such, in brief, is an outline of this Institution, which as yet is undeveloped in its details, but contains the germ of usefulness and honor for science and literature in this country. We hail with pleasure the election of Prof. JOSEPH HENRY of Princeton, to the post of Secretary of the Board of Regents. He has been chosen from a conviction of his unequalled merits for the office, although more than one hundred applications for the post were before the Board.

Prof. Henry's election to this important office, will at once command the confidence of all scientific men in the success and permanent value of this noble Institution. Under his auspices, we have a sufficient guaranty that charlatanism and pretension, in all forms, will be held aloof, while science and sound learning, with the true spirit of investigation, will be fostered to the utmost, and the object of the testator—"the increase and diffusion of knowledge among men"—be signally accomplished.

We regard the organization of this Institution (aside from the testamentary obligations which rested upon them) as an act highly honorable to our Government, as well as to the distinguished gentlemen whose intelligence and untiring energy have planned and carried through Congress the act of incorporation.

2. *British Association.*—The meeting of the British Association in September last, from the 9th to the 16th, is said to have exceeded in interest any that had preceded it. Besides a large number of the distinguished men of science of Britain, there were many present from

the continent; among whom are mentioned, Messrs. Agassiz, Œrsted, Forchhammer, Svanberg, H. Rosé, Schönbein, Matteucci, Koninck, von Middendorf, and Wartmann. The proceedings of the Association are to some extent noticed through the pages of this number, and will be further detailed in a future number. The receipts into the treasury during the past year amounted to 12,235 dollars, of which 4,500 dollars were received from members and others attending the Cambridge meeting, and the rest from dividends on stock, sale of the volumes of reports, and other items. Among the payments, we observe that 3,300 dollars were given on account of grants to aid in scientific researches, in various departments, 2,500 dollars to an assistant secretary, accountant, &c. for 18 months; and 1,000 dollars, for the expenses of the meeting at Southampton, in connection with sundry disbursements for advertising, &c.

The annual address, delivered by Sir R. I. Murchison, the President elect, presents a lucid review of the investigations in science promoted by the Association, and spirited sketches of the recent labors of some of the distinguished men present at the meeting. Of Agassiz, he says: "Switzerland has again given to us that great master in palæontology, who has put arms into the hands of British geologists, with which they have conquered vast regions, and who, now on his road to new glories in America, brings to us his report on the fossil fishes of the basin of London, which will, he assures me, exceed in size all that he has ever written on ichthyolites." Of Prof. von Middendorf: "Among these sources of just pride and gratification, no one has afforded me sincerer pleasure than to welcome hither the undaunted Siberian explorer, Prof. von Middendorf. Deeply impressed as I am with the estimation in which science is held by the illustrious ruler of the empire of Russia, I cannot but hope that the presence of this traveler, so singularly distinguished for his enterprising exploits, may meet with a friend in every Englishman who is acquainted with the arduous nature of his travels. To traverse Siberia from south to north and from west to east—to reach by land the extreme northern headland of Taimyr—to teach us, for the first time, that even to the latitude 72° north, trees with stems extend themselves in that meridian—that crops of rye, more abundant than in his native Livonia, grow beyond Yakutsk, on the surface of that frozen subsoil, the intensity and measure of cold in which, he has determined by thermometric experiments—to explain, through their language and physical form, the origin of tribes now far removed from their parent stock—to explore the far eastern regions of the Sea of Ohkotsk and of the Shantar Isles—to define the remotest northeastern boundary between China and Russia—and, finally, to enrich St. Petersburgh with the natural productions, both fossil and recent, of all these wild and untrodden lands, are the exploits for which the Royal Geographical Society of London has, at its last meeting, conferred its Gold Victoria Medal on this most successful explorer. Prof. v. Middendorf now visits us to converse with our naturalists most able to assist him, and to inspect our museums, in which, by comparison, he can best determine the value of specific characters before he completes the description of his copious accumulations; and I trust that during his stay in England

he will be treated with as much true hospitality as I have myself received at the hands of his kind countrymen."

After speaking of the labors of Œrsted and Faraday in one and the same field, he proceeds as follows, honorably noticing one of the first names of this land:

"And thus shall we continue to be a true British Association, with cosmopolite connections, so long as we have among us eminent men to attract such foreign contemporaries to our shores. If, then, at the last assembly we experienced the good effects which flowed from a concentration of profound mathematicians and magneticians, drawn together from different European kingdoms—if, then, also, the man of solid learning, who then represented the United States of America, and who is now worthily presiding over the Cambridge University of his native soil, spoke to us with chastened eloquence of the benefits our institution was conferring on mankind—let us rejoice that this meeting is honored by the presence of foreign philosophers as distinguished as those of any former year."

3. *On Boring for Artesian Wells;* by M. Fauvelle, of Perpignan, in France, (Brit. Assoc., from the Athenæum of Sept. 19, 1846.)—In this paper, which was sent to the British Association by Arago, through Mr. Vignolles, M. Fauvelle observes as follows:—"In 1833, I was present at the boring of an artesian well at Rivesaltes; the water was found, and spouted up abundantly. They proceeded to the tubing, and for that purpose enlarged the bore-hole from the top downwards. I was struck by observing that it was no longer necessary to draw the boring tools to get rid of the material, and that the water, rising from the bottom, brought up with it, in a state of suspension, all the soil which the enlarging tools detached from the sides. I immediately observed to my friend, M. Bassal, who was with me—'This is a remarkable fact, and one very easy to imitate; if, through a hollow boring rod, water be sent down into the bore-hole as it is sunk, the water, in coming up again, must bring with it all the drilled particles.' On this principle I started to establish a new method of boring. The apparatus is composed of a hollow boring rod, formed of wrought iron tubes screwed end to end; the lower end of the hollow rod is armed with a perforating tool, suited to the character of the strata which have to be encountered. The diameter of the tool is larger than the diameter of the tubular rod, in order to form around it an annular space through which the water and the excavated material may rise up. The upper end of the hollow rod is connected with a force-pump by jointed or flexible tubes, which will follow the descending movement of the boring tube for an extent of some yards. This boring tube may be either worked by a rotary movement with a turning handle, or by percussion with a jumper. The frame and tackle for lifting, lowering and sustaining the boring tube, offer nothing particular. When the boring tube is to be worked, the pump must be first put in motion. Through the interior of the tube a column of water is sent down to the bottom of the bore-holes, which water, rising in the annular space between the exterior of the hollow boring rod and the sides of the bore-hole, creates an ascending current which carries up the triturated soil: the boring tube is then worked like an ordinary boring rod; and as the material is acted upon

by the tool at the lower end, it is immediately carried up to the top of the bore-hole by the ascending current of water. It is a consequence of this operation that the cuttings being constantly carried up by the water, there is no longer any occasion to draw up the boring tube to clear them away, making a very great saving of time. Another important and certainly no less advantage, is, that the boring tools never get clogged by the soil; they work constantly (without meeting obstructions) through the strata to be penetrated, thus getting rid at once of nine-tenths of the difficulties of boring."

Sir John Guest asked Mr. Vignolles to explain the system of percussion boring, for the information of those gentlemen present who might not be acquainted with it. Mr. Vignolles said, instead of boring with augers or rods, there was a heavy weight suspended by a rope and pulley; and fixed to the bottom of the weight was a tool of the crown form, viz. a circular tool of iron, indentated at the bottom. There was no description of rock on which he had tried it that this tool did not penetrate with facility. The prejudice of English workmen, however, had hitherto prevented its introduction into this country; but he had no doubt it would make its way, particularly if it could be combined with Fauvelle's system.

4. *Discussion on the Potato Disease*, (Brit. Assoc., from the Athenæum, Sept. 19.)—Mr. W. Hogan read a paper "On Potatoes raised from seed, as a means of preventing the extension of the prevailing disease." He first read extracts from German publications, giving the result of the trial of growing potatoes from the seed of the plant, which had been found to be successful as far as the production of tubers, and also the prevention of the prevailing disease. Mr. Hogan had also tried the same process with success. The proceeding consisted in growing the seeds first in a hot-bed, and then transplanting. He considered this to be a successful way, because the most natural.

Mr. M. Stirling stated that he had, some time since, recommended to the government of Sweden the plan of procuring potato seed, and deriving thence the crops. He had advised giving prizes for the best seedling potatoes, and he also recommended hybridizing the potato as a means of improvement.—Mr. W. Ogilby thought growing potatoes from the seeds might prevent the scurf and dry rot, but not the present wet rot of the potato. He quoted several instances in which seedling crops had been destroyed. He had been most successful in growing potatoes from a little tuber which sprung from the "eyes" of the old ones going to decay.—Dr. Crook attributed the attack in the year 1845 to "cold." The cold burst the vessels; and then came the disease. Heat produces the same effects as cold; it bursts the tissues of the vessels, and the consequence is disease.—Dr. Daubeny did not think that atmospheric changes had any thing to do with the disease at all. He thought that the most satisfactory theory was that which referred the disease to fungi. He had understood that there was no potato disease in the neighborhood of the copper furnaces in Swansea.—Dr. Buckland had lately visited Prof. Payen, who advocated the doctrine that the disease arose from fungi; and he (Dr. Buckland) believed so too. There was, in fact, a fungiferous miasm existing, which, like cholera, attacked not all, but those who were predispo-

sed. It was the weak and intemperate that were attacked with cholera; it was the debilitated potato that had the disease. Extreme conditions of temperature debilitated the potato, and then it became diseased. The potatoes were suddenly attacked. He knew a case in which a whole field became diseased in three days. He believed the only remedy was mowing down the haulm of the potato the moment it was attacked.—Prof. L. PLAYFAIR was certain of one thing—and that was that the disease was not due to fungi. The nature of it was evident, as it could be produced artificially. If you scraped a potato and placed it in the open air, it became diseased; and, in the course of a few hours, the fungi would appear on it.—Mr. E. SOLLY believed that the disease depended on chemical changes, not on the attack of a fungus.—Mr. BUSH had examined the diseased potatoes under the microscope, and in the early stages had always failed to discover the slightest indication of the existence of a fungus. As the disease advances, first one fungus appears, and then another,—and at last animal life. This was the progress of all vegetable decay. The disease always commences on the outside of the potato, and proceeds to the centre. He had also found the disease constantly attended with the development of crystals of oxalate of lime.—Prof. BALFOUR stated that some fungi attacked living and healthy structures,—others only diseased ones. The fungus of the potato was a Botrytis; which he believed attacked healthy structures.—Mr. A. STRICKLAND said, in reference to Dr. Buckland's recommendation to mow down the potatoes, that when his neighbors mowed down their potatoes he dug his up. They had lost nearly all theirs, whilst he had saved nearly all his.—Dr. LANKESTER remarked on the want of evidence to support the theories of either cause or remedies that had been brought forward. Cold and heat had been said to act, by destroying the tissues of the potato; but no destroyed tissues had been shown to exist. Debility had also been supposed to exist; but no proof was given of the existence of debility: and the Dean of Westminster himself had admitted that he had seen the healthiest potatoes destroyed in three days. Positive observation was evidently opposed to the fungus theory. As to the remedies recommended, seedlings had been known to be attacked in more cases than they had escaped; and, therefore, sowing the seeds could not be recommended. Mowing down the stalks had not been more successful than letting them alone; and it ought now to be known, that this meeting had done nothing more valuable than to show the insufficiency of all theories and remedies hitherto advanced.

5. *On the Educational Statistics of Oxford*, (Proc. Brit. Assoc., Sept., from the Athenæum, Sept. 19, 1846.)—Mr. HEYWOOD described the almost exclusive attention paid to classical studies, and the neglect of mathematical and physical pursuits. But he particularly directed attention to the results of the examination called the "Great Go," with which a theological examination is connected at Oxford, including not merely the historical books of the Bible, but also an accurate knowledge of the thirty-nine articles and of the texts usually quoted in proof of their several propositions. Some criterion of the working of the system may be found in the number of unsuccessful candidates. The annual average of candidates for degrees is 410—of whom only 284 pass, while 126 are rejected. Thus about one-third are unsuccessful,

after having kept fifteen terms, which require a residence of three years and a half. In this examination Aristotle appears to be the favorite author at Oxford; and the examiners appear to pride themselves in selecting the most difficult and abstruse portions of his rhetorical and ethical works, looking rather to the difficulties of grammar and philology than to their ethical value. Science is the technical term at Oxford for moral philosophy, and each separate treatise is called a science; —thus a student who has read Aristotle's Ethics and Rhetoric, a Dialogue of Plato and Butler's Analogy, is said to have got up four sciences. Aldritch's Compendium and Aristotle's Organon are the chief authorities in logic, and a power of commenting upon them can be acquired only by a long and painful course of minute study. Mr. Heywood's object was to call attention to the neglect of the mathematical and physical sciences, and to the great proportion of persons rejected or plucked at the final examination, and contended that these evils were avoided by the system pursued at Cambridge.

6. *Modification of Dr. Whewell's Anemometer, for measuring the Velocity of the Wind;* by Dr. ROBINSON, (Brit. Assoc., from the Athenæum, Sept. 19, 1846.)—Dr. Robinson explained to the section verbally the nature of the various anemometers hitherto employed to measure the *force* of the wind, and distinguished Whewell's from them, as a measure merely of comparative *rate*. The fault of it was, that the instrument gave no absolute measure of velocity in miles per hour, and that it reduced the rates to no standard, and therefore the observations made at one observatory were not capable of comparison with those at another. He had applied an observation of Mr. Edgeworth, who was a family connexion of his own, to the construction of such an addition as would render Whewell's anemometer more perfect in this respect. He mounted on a vertical axis three or four arms, carrying hemispherical cups at their extremities. These cups opposed much less resistance to air acting on the concave sides than on their convexities, and in such ratio that uniform revolution was produced at the rate of *one-third* of the velocity of the wind. From this measure, which would be the same for all sizes of the instrument, and at all places, the mean velocity of the wind during a given period could always be obtained in miles per hour. He concluded by reading some of the determinations of his own instrument at the observatory at Armagh.

7. *On the Ethnological Distribution of Round and Elongated Crania;* by Prof. RETZIUS, (Proc. Brit. Assoc., from the Athenæum, Sept. 19.)—On this paper a lengthened discussion arose on the degree to which physical peculiarities of races may become modified by climate, education, progress of civilization, and the effect of dwelling with higher races. Mr. Lyell gave it as the result of his recent observations in the Southern States of America, that the negro race is much altered by living even for a few generations with the white races, and always for the better, even when no mixture of races exists; and that where it does exist, the result is ever to retain and propagate the higher developments of the white races.

8. *On the Deviation of Falling Bodies from the Perpendicular;* by Prof. OERSTED, (Brit. Assoc., from Athen., Sept. 26, 1846.)—I shall give a short history of these experiments, as far as this can be done by

memory, without any assistance of books. The first experiments of merit were made, I think in 1793, by Prof. Guglielmini. He made bodies fall from a height of 231 feet. As the earth rotates from west to east, each point in or upon her describes an arc proportioned to its distance from the axis; and, therefore, the falling body has, from the beginning of the fall, a greater tendency towards the east than the point of the surface which lies perpendicularly below it. Thus, it must strike a point lying somewhat east of the perpendicular. Still, the difference is so small, that great heights are necessary for giving only a deviation of some tenth parts of an inch. The experiments of Guglielmini gave indeed such a deviation; but at the same time, they gave a deviation to the south, which was not in accordance with the mathematical calculations. Laplace objected to these experiments, on the ground that the author had not verified his perpendicular, until some months afterwards. In the beginning of this century, Dr. Benzenberg undertook new experiments, from a height of about 240 feet. The book in which he describes his experiments contains, in an appendix, researches and illustrations upon the subject from Gauss and Olbers; to which several abstracts of older researches are added. The paper of Gauss is ill printed, and therefore difficult to read; but the result is, that the experiments of Benzenberg would give a deviation of 395 French lines. The mean of his experiments gave 399; but they gave a still greater deviation to the south. Though the experiments here quoted seem to be highly satisfactory in point of the eastern deviation, I cannot consider them to be so in truth; for it is but right to state that these experiments have considerable discrepancies among themselves, and that their mean, therefore, cannot be of great value. In some other experiments made afterwards in a deep pit, Dr. Benzenberg obtained only the easterly deviation; but they seem not to deserve more confidence. Greater faith is to be placed in the experiments tried by Prof. Reich in a pit of 504 feet, at Freiberg. Here the easterly deviation was also found in good agreement with the calculated result; but a considerable southern deviation was observed.—Prof. Oersted added various reasons and suggestions with reference to repeating the observations.

Sir J. Herschel said, that from a conversation with M. Oersted he had been inclined to think that the deviation of falling bodies towards the south in these northern latitudes—which was an observed fact, although hitherto unaccounted for—might receive an explanation from the circumstance that electrical currents were known to be in circulation around the earth in the direction of parallels of latitude; and as a current is always excited in a body moving across such a current, these would give rise to a mutual repulsion, causing the deflection towards the south. But inasmuch as their action would be but momentary were the velocity constant, and is developed in proportion to the variation of the velocity, hence, since the velocity increases uniformly with the time, a uniformly-acting force is the result; and the total deviation, therefore, towards the south would be in the proportion of the height from which the body descended, since it is easy to see that its entire course would be rectilinear. This fact, therefore, which could readily be determined by well conducted observations, would be a decisive test

of the soundness of the opinion; and this was the chief object which M. Oersted had in view. From a subsequent conversation, however, with Mr. Grove, he was inclined to be more doubtful of this explanation. Mr. Grove said, that inasmuch as a falling body was moving between electrical currents, placed both north and south of its line of fall, in his opinion the effect of the one would counterbalance that of the other, so as together to produce no effect.—M. Oersted said that his present object was merely to induce competent persons to undertake well-directed experiments for ascertaining whether there truly was a southerly deviation of falling bodies or not.

9. *Method of Measuring the Height of Clouds;* by Dr. Whewell, (Proceedings Brit. Assoc. in Athen. Sept. 26.)—I do not know whether it has been observed how easily the height of clouds may be measured when the reflection of them can be seen in a lake from a station above it. In that case the angle of elevation above the horizontal plane for any selected point of a cloud is not equal to the angle of depression of the image; for the latter angle is the angle of elevation of the cloud *at the point of the lake* where reflection takes place, and is, therefore, greater than the former. The difference of these two angles gives us the means of determining the height of the cloud. If $\alpha$ be the angle of depression of the image of the cloud-point, $\beta$ the angle of elevation, and $h$ the vertical height of the station of observation above the level of the lake, it is easily shown by trigonometry that the height of the cloud above the level of the lake is

$$h\frac{\sin.(\alpha+\beta)}{\sin.(\alpha-\beta)}$$

The angles $\alpha$ and $\beta$ may be measured by any contrivance for measuring elevations and depressions: for instance, a graduated quadrant with a plumb line, or hanging *alidade* and plain sights. No great accuracy is attainable or is needed in this inquiry.

10. *Gauss's Magnetic Constants*, (Proc. Brit. Assoc. in Athenæum, Sept. 19, p. 962.)—M. Ermann presented a report to the British Association, containing the reduction of various magnetic observations made by him between the years 1828 and 1830, applied to determining the Constants for 1829. The observations were made at 650 nearly equidistant stations around the globe, between the parallels 62° N. and 60° S.; of this number, those of 283 stations had been reduced, and at great labor, as is seen from the fact that they involved 180,000 calculations, each of which required the table of logarithms to be consulted five times.

11. *Hydrodynamics*, (Proc. of Brit. Assoc., in Athenæum, Sept. 19, p. 963.)—An elaborate report on fluid motion, waves and tides, discharge of gases through small orifices, sound, simultaneous oscillations of fluids and solids, and other points in Hydrodynamics, was read before the British Association, by G. B. Stokes. Under the head of waves, the researches of Mr. Green, Prof. Kelland, and Mr. Airy were particularly alluded to, and the accurate agreement of theory with the experiments of Mr. Scott Russell, was pointed out.

12. *Refraction and Diffraction of Waves of Sound*, (Brit. Assoc., from the the Athenæum, Sept. 19, 1846.)—Mr. Whewell concluded some remarks on waves, before the British Association, by saying, that

as waves of sound were reflected echoes, so he conceived they must suffer refraction; though the observing of this was attended with experimental difficulties; but that these waves were *diffracted*, he conceived no one could doubt who would attend to the varying sound of a cascade, as you approached it round a bending course, it being at first hidden from sight by interposed rocks, banks or other obstacles.

13. *Weather.*—M. ARAGO in a recent memoir, (Jameson's Edinb. Jour., xli, 2,) announces and supports the opinion that "whatever the progress of the sciences, never will observers who are trustworthy and careful of their reputation, venture to foretell the state of the weather." In a previous memoir he had shown that the influence of the moon and of comets is not appreciable, and that predictions of the weather cannot therefore become a branch of astronomy properly so called.

14. *North Pole.*—Capt. PARRY and Sir JOHN BARROW urge the importance and practicability (Jameson's Jour., xl, 295) of reaching the North Pole. The plan proposed by Capt. Parry is to leave the ship at Hakluyt's Headland (where a previous winter had been spent) in the month of April, when the ice would present a hard, unbroken surface. It is supposed that the party might make good thirty miles a day, and complete the enterprise in the course of the month of May, before the ice broke up. Sir John Barrow suggests that two vessels properly constructed and furnished with screw propellers, might sail to the pole, starting from latitude 80° in the month of August. Making but twenty miles a day, it would take but a month to go the 600 miles from Hakluyt's Headland to the point of the axis on which the earth turns; and they might remain there a month, and within a fortnight after reach Spitzbergen.

15. *Dust falling on Vessels in the Atlantic.*—This phenomenon is most frequent near the Cape Verds, and it is shown by Mr. DARWIN, (Proceed. Geol. Soc. London, No. 5, p. 27,) to be derived from the African coast. Ehrenberg found sixty-seven species of infusoria in dust collected by this traveler and Lieut. James. They were with one exception of known species, and all but two were of freshwater origin. It was remarked that among them were African species, but no characteristic African forms.

16. *The first Atlantic Steam Navigation.*—In the Gentleman's Magazine for June, 1845, is published an epitaph from the monument lately erected over Capt. Roberts, the lamented commander of the ill-fated steamer President, in which the statement is made that Capt. Roberts was the first who ever crossed the Atlantic in a steam ship. A reference to Vol. xxxviii, p. 155 of this Journal, will show the error of this assertion. The steam ship Savannah, Capt. Moses Rogers of Savannah, Ga., in 1819 successfully crossed and recrossed the Atlantic, using steam during the greater part of her voyage. It was nearly twenty years after this event that Capt. Roberts made his first voyage in a steam ship to the United States.

Our attention was called to the passage alluded to, in the Gentleman's Magazine, by a letter from William Goodman, Esq., of New York, author of "The Social History of Great Britian."

17. *Fall of Meteorites;* (L'Institut, No. 666, Oct. 7.)—A fall of meteorites took place, on the 8th of May last, on both banks of the river Potenza, in Italy, to the northeast of the village of Monte-Milone, eight miles from Macerata. A quarter after 9 A. M. there was a violent report heard,

which was followed after three minutes by a fall of stones, one of which was dug out immediately after from a hole 66 centimeters in depth. It weighed about a pound. A great number of pieces fell, and the greater part in the bed of the river. The largest obtained weighed six pounds. The exterior is a black crust; within the color is grayish white. The texture is semi-crystalline, and it presents small metallic points. Some trials indicated the presence of magnetic pyrites, nickel and cobalt, but no chrome. The grayish white mass appeared to be Labradorite or Albite. It resembles, it is stated, the meteorite which fell the 16th of Sept., 1843, near Nordhausen, of which a complete analysis has been given by Rammelsberg.

18. *Footmarks in the New Red Sandstone of Storeton, near Liverpool;* by JOHN CUNNINGHAM, (Jour. Geol. Soc., No. 8, p. 410.)—Mr. Cunningham has detected small footprints in the Storeton sandstone, which from their form he refers to the order Grallæ of birds. The tracks were ten inches apart, and as far as in view were right and left successively.

19. *Explosive Paper.*—M. Pelouze mentions a discovery by which it is easy to ascertain whether the paper has been well prepared. If the paper dissolves in ether it is perfect; if not it has been badly prepared.

20. *Gun-Cotton,* (Athenæum, No. 996.)—Gun-cotton has been rejected for military purposes by the British Board of Ordnance, on account of its exploding at a much lower temperature than gunpowder, and also its producing moisture within a gun.

Prof. Schönbein has lately stated that his Gun-cotton is not identical with the Xyloïdine of Braconnot and Pelouze. The latter is soluble in acetic acid, while Gun-cotton is wholly unaffected by it. He also says that there are other differences, which will, after a while, be made known.

The Bavarian Government have made Gun-cotton, like gunpowder, a government monopoly.

*Gun-sawdust* has lately been made, which has the same properties as Gun-cotton, though less effectual.

21. *Railways in Italy,* (Athenæum.)—The net of railway in Italy which the Pope seems disposed to grant, will embrace six principal lines; from Rome to the frontier of Naples; from Rome to Civita Vecchia; from Civita Vecchia to the frontier of Tuscany; Bologna to Ferrara; Forli to Ravenna. There is talk also of two great lines from Civita Vecchia to Ancona, and from Ancona to Bologna.

22. The opening of the *Eighth Congress of Italian Savans* took place on the 13th of September. The Prince of Canino brought a message from the Pope to the effect that his Holiness recognized the value of such associations, for the promotion of science, and saw gladly his subjects of the Roman States engaged in them. The meeting was less fully attended than the former one at Naples.

23. A *monument to Columbus* is now erecting at Genoa, in the centre of the Piazza del Acqua Verde. In the four angles of the basement there are to be emblematic figures, representing Science, Piety, Prudence, and Constancy, and on the sides bas-reliefs, expressing incidents in the history of the Genoese hero. Above there will be a group representing Columbus in the act of discovering America. The design is by Michele Canzio, and the execution of the principal group by Bartolino.—*Athen.*

24. The present depth of the *Artesian well in the Duchy of Luxemburg* is 2336 feet, or 984 feet greater than that of Grenelle near Paris.

It is said that this immense work has been undertaken for the purpose of reaching a large stratum of common salt.

25. *Native gold* is reputed to have been found in South Australia in a shaft undertaken for the discovery of copper ore.—*Athen.*

OBITUARY.

26. *T. Monticelli,* (from the Address by T. Horner Esq. before the Geol. Soc. London, Quart. Jour. Geol. Soc., No. 6, p. 146.)—THEODORE MONTICELLI of Naples, the Foreign Member whom we have lost, was born in 1759, in the celebrated city of Brundusium, the modern Brindisi. He was educated in the Benedictine College at Rome, in which Chiaramonte, afterwards Pius VII, was then professor, and where he made so much progress in his mathematical studies as to be able, while yet a very young man, to deliver a course of lectures on Natural Philosophy at Naples. In 1792 he was elected Professor of Ethics in the University there, but soon after, getting involved in the political troubles of that time, he was thrown into prison, and was confined six years. When he recovered his liberty in 1800 he went to Rome, where he was very kindly received by his old tutor, by that time raised to the Popedom; and some years afterwards he was nominated by Napoleon to be employed with others in the re-establishment of the University and Academy of Sciences of Naples, of which latter body he was in 1808 elected Perpetual Secretary.

About this time he directed his attention with great earnestness to the study of Vesuvius, forming a very rich collection of its products. He contributed many memoirs to the Academy, in which he described the active volcanic phenomena which he watched with unceasing assiduity, their modern products, and those of the earlier history of this celebrated mountain. In 1813 he published an account of a great eruption of that year, which he dedicated to Sir Humphry Davy, with whom he was intimately acquainted; and Davy, during his residence at Naples some years afterwards, studied the structure and phænomena of Vesuvius under his guidance. Some years afterwards Monticelli published his 'Storia de' fenomeni osservati nelle eruzioni del Vesuvio,' and in 1825, in conjunction with Covelli, his 'Prodromo della Mineralogia Vesuviana,' which deservedly added to his reputation. In 1827 he was one of a committee appointed by the Academy to draw up a geological description of the island of Ischia; a work which was accomplished, and illustrated by several topographical and geological maps, but which has not yet been published. He also drew up for the Academy a memoir, which was printed in Latin, entitled 'Commentarius in agrum Puteolanum Camposque Flegræos.' He continued to the last an ardent cultivator of science, and died Secretary of the Academy, having filled the office thirty-seven years. He was alive during the Scientific Congress at Naples last September, but was too infirm to take a part in its proceedings. He was living in retirement at his favorite Pozzuoli, and in the month of October, when a few friends had assembled to celebrate his 87th birthday, he was seized at dinner with apoplexy, which terminated his life.

27. *M. Aimé.*—The French papers mention the death of M. Aimé, a young scientific gentleman of distinction, and director of the Observatory at Algiers. While proceeding to Medeah to establish an observatory at

that place, he had the misfortune to fall into a ravine, breaking his leg and several of his ribs. He died a few days afterwards, in the 33d year of his age.—*Athen.*

28. *Mr. Isaiah Lukens*, an eminent philosophical artist, died at Philadelphia, his place of residence, Nov. 13th, 1846, aged 69 years. He was, at the time of his death, Vice President of the Franklin Institute, a post which he had held for many years. His death is a serious loss to the scientific arts in this country.

## VI. Bibliography.

1. *First Principles of Chemistry, for the use of Colleges and Schools;* by Benjamin Silliman, Jun., M. A., Professor of Science applied to the Arts, in Yale College. 492 pp., 12 mo., with more than 200 illustrations. Philadelphia, Loomis & Peck, 1847.—In connection with the announcement of this work, we cite a few paragraphs from the author's preface.

"The object of this work is sufficiently indicated by its title. It has grown out of the exigencies of instruction, and has been received as the Text Book in the Public Lectures at Yale College.

"It has been a leading object in its composition not to anticipate the student's acquirements, but to carry him forward, step by step, in a series of consecutive propositions. To aid him as much as possible in applying the knowledge already acquired, the paragraphs have been numbered and constant reference has been made throughout the work to previous sections, wherever the subject could be illustrated by so doing. The questions at the foot of each page are designed to aid those whose experience in teaching Chemistry may not be sufficient to enable them at all times to determine what is most important for the pupil to know."

2. *Second Annual Report on the Geology of Vermont;* by Prof. C. B. Adams. 8vo, pp. 267. Burlington, 1846.—This survey has been prosecuted with great activity during the past year, by its energetic head. The amount of detail set forth in the present report, shows that no time has been misspent, and no means misappropriated in accomplishing the great object in view. There are many geological topics which the rocks of Vermont are peculiarly well suited to illustrate—of which none are more conspicuous than the phenomena of drift and the effects of metamorphic action: while the resources of the State in its metallic ores, marbles and soils are calculated to excite great interest in the results of the explorations.

3. *Chemical Essays relating to Agriculture;* by E. V. Horsford, A. M.: or analyses of grain and vegetables, distinguishing the nitrogenous from the non-nitrogenous ingredients, for the purpose of estimating their separate value for nutrition. Also, on ammonia found in glaciers; and on the action and ingredients of manures. Boston, James Munroe & Co., 1846. pp. 68.—The principal research embraced in these important investigations, relates to the value of different kinds of vegetable food, as based upon their per-centage of nitrogen. This subject was taken up at the suggestion of Baron Liebig, and has been prosecuted in his Laboratory, where for two years past Prof. Horsford has been a student. Some notice will be found of his results in Vol. ii, p. 264, of this Journal. It is truly honorable to the science of this country, to have presented to the world such papers as this by Mr. Horsford, and that by Mr. Norton on oats. Original chemical research among us has been uncommon; nearly every thing of the sort heretofore done in this country has been either in the

line of Mineral analysis, or of the proper *physics* of Chemistry, rather than in the path which these gentlemen have followed.

4. *On the Analysis of the Oat;* by JOHN P. NORTON, Professsor of Agricultural Chemistry, &c., in Yale College. This essay was prepared at the request of the Highland Agricultural Society of Scotland, and received last spring their premium of fifty sovereigns, offered for the best essay on the chemical constitution of the great staple of Scotch agriculture. Our countryman, Mr. Norton, in the laboratory of the Agricultural Chemistry Association in Edinburgh, and under the direction of Prof. Johnston, enjoyed great advantages for the prosecution of such an investigation. Mr. Norton commenced with the young plant, and followed it through its successive stages of growth and development to maturity. The results are presented in thirty-nine tables, containing hundreds of accurate and minute analyses, giving the composition of the oat from the different parts of the plant separately, viz. the leaf above and below, the stalk, the knots, the grain, &c., besides the organic constitution of the grain; and thus illustrating interesting points in the constitution of the plant, and its relation to the soil.

5. *Encyclopædia Americana;* supplementary volume; by HENRY VETHAKE. Vol. xiv, pp. 663. 8vo. Lea & Blanchard, Phil. 1847.—The "Conversations Lexikon" has become a household book in all the intelligent families in America, and it is undoubtedly the best depository of biographical, historical, geographical, and political information, of that kind, which discriminating readers require. There is in the present volume much matter purely scientific, which was all the more acceptable to us that it was unexpected. Prof. Vethake has shown good taste and skill, with great research, in compiling this important continuation of the original work. Among the scientific heads are well digested articles on geology, electricity, and magnetism; the telegraph; the causes which produce the explosions of steam boilers, &c., in which we find much information not elsewhere to be met with in a condensed form. The personal sketches are confined, in case of Americans, to those who are dead, but many very entertaining and instructive biographies are given of living Europeans of eminence in science and letters.

6. *Chemistry of the Four Seasons, Spring, Summer, Autumn, and Winter;* an essay principally concerning natural phenomena admitting of interpretation by chemical science, and illustrating passages of Scripture; by THOMAS GRIFFITHS, Professor in the Medical College of St. Bartholomew's Hospital. Author of "Recreations in Chemistry," &c., &c. London. Philadelphia. Lea & Blanchard. 1846. 12mo. pp. 451.—The design of this little volume is good, the style pleasant and familiar, and the illustrations copious. The scope of the work is well expressed in the title, and the tendency of such books when well written and by competent hands, is favorable to the popularity and progress of science.

7. *Précis de Chimie Organique;* par M. CHARLES GERHARDT, (tome deuxième.) Paris. Fortin Masson, et Cie. 1846. 8vo.—Chemists will be glad to see the second volume of Gerhardt's Précis, &c., a work which is looked upon with great interest by all who follow the progress of organic chemistry, whether they adopt the views of the new French school, (of which Gerhardt and Laurent are the exponents,) or those of the school of Giessen; or the still older opinions of the great Swede. This author is, beyond doubt, one of the bright lights of organic chemistry, and so thought Liebig when Gerhardt translated the "Traité de

Chemie Organique" from the author's manuscripts, although the Professor of Chemistry at Montpelier (Gerhardt) seems at present to be held in light esteem at Giessen.

8. *Geological Observations on South America*, being the third part of the Geology of the Voyage of the Beagle, during the years 1832–1836; by CHARLES DARWIN, M. A., F. R. S., F. G. S., Naturalist to the Expedition. 268 pp., 8vo, with numerous plates. London, 1846.—This work, just from the London press, is one of the most valuable contributions to geological science of late years, evincing throughout the careful and accurate observer, and a mind that can appreciate the bearings of facts in their various relations. The citation on page 120, is from this volume. The author's observations were made with system and fullness, and the work is valuable, as well for its illustrations of general principles in geology, as for details respecting the structure of the regions of which it treats.

9. *The Trees of America;* by D. J. BROWNE.—We are authorized to announce that the success of the work by Mr. Browne, on the trees of America, has been such as to warrant the preparation of a second volume, of the size and character of the first, and that nearly one half of the engravings are already executed. We are also pleased to learn that another edition of the existing volume will soon be issued, with such additions and emendations as will render it the most useful and entertaining work of any on the subject.

10. *Eureka, or the Journal of the National Association of Inventors;* published by W. H. Starr, New York.—This Journal, recently established, is a monthly quarto, devoted to the discoveries in science and inventions in the arts; and as such, as well as for its own merits, it is entitled to the patronage of all friends of improvement.

11. *The London Geological Journal and Record of Discoveries in British and Foreign Palæontology.* 40 pp., 8vo, with 8 lithographic plates; 3*s.* 6*d.* London.—This is the title of a new Geological Journal, the first number of which, printed in an elegant style, made its appearance in September last. This number contains several Palæontological articles of interest, handsomely and more expensively illustrated than is usual in scientific periodicals.

12. *Lichenes Exsiccati Amer., Sept.*—Under this title, Mr. Edward Tuckerman, of Cambridge, Mass., proposes to publish descriptions of North American Lichenes, in successive volumes, if sufficient matter shall be supplied to warrant the undertaking. Considerable labor has been devoted by him to this branch of botany during the last eight years, and he has received some important collections from others interested in these plants. The object of this notice is to commend the proposed work to botanists, and especially to those at the south, and southwest, from whence scarcely any specimens of Lichenes have reached him. He hopes moreover, that enough may in this way be accomplished to enable him to prepare a *Synopsis* of our Lichenes and Byssaceæ, with full descriptions. Specimens sent should be pressed sufficiently for the herbarium. If gathered dry, this can be done by slightly moistening them.

13. *Sertum Petropolitanum; seu Icones et Descriptiones Plantarum, quæ in Horto Botanico Imperiali Petropolitano floruerunt*, 1846: Auct. F. E. L. FISCHER et C. A. MEYER.—Of this work we have the first fasciculus, in imperial folio, published in a style of imperial magnificence. There is a prefatory account of the palm house, now in the course of erection at St. Petersburg Garden, which is 266 feet long, 80 feet broad, and 67 in

height. Besides this, the combined length of the other conservatories amounts to hardly less than 3750 feet. Of the ten species illustrated in this fasciculus, the following are natives of California, and were raised from seeds gathered near the Colony Ross, on the Bay of St. Francisco, at the time the Russians occupied that station; viz., *Callichroa platyglossa*, F. and M., the closely allied *Calliglossa Douglasii*, Hook. and Arn., and *Baeria chrysostoma* F. and M.; appended to which is an interesting note proposing to constitute of these genera and their near relatives *Lasthenia*, *Burnellia*, *Hymenoxys*, &c., along with Monolopia and Coinogyne, a separate section in the tribe Anthemideæ. Lastly, with a fine illustration of *Nemophila liniflora*, F. and M., a new arrangement of that genus is given under these sections, and eight species are characterized. Among them a new one, *N. microcalyx*, is proposed, founded on *Ellisia microcalyx*, Hook., a little plant of Louisiana, Alabama, and Georgia, which has been supposed to be merely a form of *N. parviflora*. A. Gr.

14. Endlicher and Martius, *Flora Brasiliensis*.—The sixth part, published in July last, comprises the *Solanaceæ* and *Cestrineæ* of Brazil, by Dr. Sendtner of Munich, pp. 227, fol., with nineteen plates, to which Prof. Von Martius has added an interesting excursus on the geographical distribution and the history and uses of the Solanaceæ, especially of tobacco. Of the six physognomic plates which this fasciculus contains, two are devoted to views from the summit of the Concorado, and a third is a fine illustration of a Brazilian forest, taken from some part of the slope of the same mountain. A. Gr.

15. Trautvetter, *Plantarum Imagines et Descriptiones Floram Russicam Illustrantes*. Munich. Fasc. 1–7, (1844–6,) pp. 54, tab. 1–35. 4to.—These are the earlier fasciculi of a work designed to illustrate a considerable number of plants of the vast flora of the Russian dominions, which have not yet been figured, at least in a sufficient manner. The plates, like the text, are in small quarto, and are neatly engraved on stone in the style which is so well executed at Munich. The work is dedicated to the Prof. Trautvetter's former preceptor, the accomplished Ledebour, the author of the *Flora Altaica*, the splendid *Icones Pl. Fl. Ross. Illustr.*, and the *Flora Rossica* now in progress. A few of the plants that have been figured belong to North West America, viz., *Cupressus Americana*, Trautv. t. 7, (the Thuja excelsa of Borgard,) which, however, was long ago referred to Cupressus (Nutkatensis) by Lambert, and was taken up under this name by Hooker. *Phlox Sibirica*, L. t. 24; *Primula Sibirica*, Jacq. t. 30; *Saxifraga serpyllifolia*, Pursh, var. *viscosa*, Trautv. t. 31; and *S. stellaris*, var. *foliolosa*, *R. Br.* t. 35. A. Gr.

16. Hooker, *Species Filicum*, being *Descriptions of all known Ferns*, illustrated with plates, part iv, London, 8vo, pp. 193–245, tab. 60–70.—To this fasciculus, which completes the first volume of a work which has long been a desideratum, the learned and indefatigable author has added a preface which will be read with interest. It would appear, contrary to the opinion which has generally prevailed, that the species of Ferns often have a very wide geographical range, and are found to inhabit points of the earth's surface the most remote from each other. For example, the habitat of *Cistopteris fragilis* embraces North Europe, North America, West Indies, Mexico, Chili, Northern India, Abyssinia, Madeira, the Azores, and the Cape of Good Hope! A. Gr.

17. *Plantes Nouvelles ou Rares d'Amerique;* par Steph. Moricand, fasc. 1–8, pp. 140, plates 1–84. 4to. Geneva, 1833–44.—The greater

part of the plants illustrated by M. Moricand are from tropical America; but there are several from Texas, selected from Balandier's collections, viz., tab. 2, *Trifolium Bejariense*, Moric., which is the T. macrocalyx of Hooker's Icones, t. 285. The former name must take precedence, as it was published several years earlier than the other. Tab. 25, *Sida filiformis* (from Tampico) seems to be very nearly the same as S. filicaulis, *Torr.* and *Gr.*, but it has not a hisped stem. Tab. 26, *Platanus Mexicanus*, from Mexico, needs to be compared with the California species. Tab. 44, *Dalea agastachys*, Moric., is Petalostemon obovatum, *Torr.* and *Gr.* Tab. 45, *Dalea penicillata*, Moric., is D. laxiflora, *Pursh.* Tab. 69, *Berberis trifoliolata*, Moric., is a species which was gathered by Drummond without flowers or fruit, and is mentioned in the Flora of North America, p. 662. A. Gr.

18. Ledebour, *Flora Rossica*, fasc. 7; (Stuttgard, 1846.)—This fasciculus completes the second volume of the work. It contains the remainder of the *Compositæ*, and the *Lobeliaceæ*, *Campanulaceæ*, *Vaccinieæ*, and *Ericaceæ*. A. Gr.

19. *Symbolæ Caricologicæ of* Drejer.*—It has been the great effort of the author in his work on Carices, to exhibit the affinities or natural relations of the various species of the genus he has so faithfully studied. While the result evinces great care and extended examination and comparison, as honorable to himself as to the learned society which has published the work, it is likely to meet with some opposition, as Drejer himself so freely and abundantly differs from some of the most distinguished European writers on this subject. It is due to some American authors at least to state, that he has given an erroneous view of their arrangement of the American species. For the sake of more ready access to the species, they took certain *artificial* characters, as was then usually done, for the outline of their arrangement, and associated those species which nearly resembled each other according to these artificial characters. This was the plan adopted by myself. Thus *C. Shortiana*, Dew., upon which Drejer employs much effort, was referred to the same section as *C. formosa*, Dew., *C. gracillima*, Schw., and *C. virescens*, Muh., because the stigmas are three, the terminal spike androgynous and pistillate above, and the other spikes pistillate—all obviously artificial, but rendering the species readily accessible by the examiner. Drejer refers this species to his family, *Melananthæ*, or the *black-flowered*, a distinction not wholly removed from the *artificial*. The reader of the *Symbolæ Caricologicæ*, will carry this explanation to the remarks on the affinities of *C. glaucescens*, Ell., *C. stenolepis*, Torr., and *C. Cherokeensis*, Schw., and be satisfied how utterly the distinguished Drejer has misapprehended those American writers on Carices. In the opinion of Drejer, *C. undulata*, Kzc., is not a distinct species, and is unnecessarily separated from *C. pallescens*, L., in which he will be approved by some American botanists. He also maintains the strong affinity of *C. Deweyana*, Schw., with *C. Cherokeensis*, thus confounding the so often repeated distinction between the *Vigneæ* and the *Legitimæ*, two great natural divisions of Carices.

Amidst the confusion of synonyms, it is gratifying to hear from Drejer that "this is a matter of less importance, since it is not so difficult to refer the plants published under diverse names to the true synonyms, provided they have been well and clearly described." C. Dewey.

* See this Journal, last volume, page 302.

20. *Instruction in Chemical Analysis* [*Quantitative*]; by Dr. C. Remigius Fresenius, edited by J. Lloyd Bullock. I. Churchill; London, 1846. 8vo, pp. 626.—This is essentially an elementary work, as only the more commonly occurring substances are mentioned; yet it will prove acceptable even to the proficient.

The characteristic feature of the work is its minute and systematic arrangement, by which all repetition is avoided, and facility of reference is promoted. The portion of the work treating of "Operations" and "Reagents," although in part a continuation of the former volume, is exceedingly valuable. The most minute precautions are given, and above all, the true spirit is inculcated—that of never trusting to chance or to compensation of errors, for correct results.

The inorganic elements are treated under three heads—1st, The composition and properties of the forms in which substances are separated and weighed. 2d, The process of determination. 3d, The separation of substances from each other. The subject of organic analysis is well treated, but with too little notice of the methods not of the Giessen School. This is indeed the fault of the whole work.

The chapter on calculation of analyses and formulæ is full, and together with the tables, forms one of the most serviceable parts of the work to the student. The "Special Part," treating of the analysis of mineral waters, of ashes, of soils, and of atmospheric air, is the most complete treatise on these subjects in the English language. An Appendix contains a series of well arranged "Examples for Practice," particularly useful to those who are deprived of the advantage of personal instruction.

21. *Taschenbuch für Freunde der Geologie;* von Karl Cäsar v. Leonhard; Erster Jahrgang; mit einem Stahlstiche, einer Lithographie und mehreren Zwischendrücken. 240 pp., 8vo. Stuttgart, 1845.—This work is properly a geological annual, and is intended to give a popular view of the more important geological facts, discoveries and theories. It brings within a small scope, truths and principles which are scattered through the periodicals and published works of various languages, and thus offers to the general as well as scientific reader, in an attractive style, the results to which this rapidly advancing science has arrived. It is literally, what the title signifies, a book for the Friends of Geology. The volume before us—the first of a proposed series—contains essays on gold, silver, and the other metals; on fossils; the artificial formation of minerals; facts relating to the various rocks, and their economical uses; on caverns; coal deposits, mountains, meteoric stones, the sea, rivers, land, coral islands, snow, ice, and various other topics, about which much valuable and entertaining information is given.

22. *Astronomical Observations made at the Naval Observatory, Washington;* by Lieut. J. M. Gilliss, U. S. N., Washington, 1846, 8vo, pp. xxv, and 671.—This volume contains the results of four years observations with a transit instrument, which although unequal in power and precision to the demands of a fixed Observatory, appears to have been used with promising fidelity. The instrument was constructed by Troughton for the United States coast survey in 1815. The object-glass has a clear aperture of 3·75 inches with a focal length of 63 inches. The length of the axis is about 35 inches. In the principal focus are five vertical lines and one horizontal; and the eye piece moves in a slide so that it may be brought opposite each wire in succession.

The primary object of these observations was the determination of the longitude of places visited by the United States Exploring Expedition, by means of corresponding moon culminations. These were observed by Lieut. Gilliss with great fidelity and during the last two months of 1838 he obtained 24 Moon culminations.

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| the year | 1839 | " | " | 80 | " " |
| " | 1840 | " | " | 104 | " " |
| " | 1841 | " | " | 113 | " " |
| six months of | 1842 | " | " | 44 | " " |
| Making in all | | | | 365 | " " |

In connection with the moon, Lieut. Gilliss not only observed the prescribed stars of the Nautical Almanac, but a great many others in various parts of the heavens, amounting in all to 1248. These have been reduced by Prof. Bradford under the direction of the Secretary of the Navy, and thus furnish us with a large catalogue of stars, to which the polar distances have been appended from the British Association Catalogue. The observations of the same stars on different nights agree remarkably well with each other, almost as well as those made at Greenwich. This Catalogue must prove highly useful and convenient to those who have not access to larger collections.

We cannot but admire the promising industry of Lieut. Gilliss, and we trust that so laudable a zeal for scientific observation may hereafter find full scope for its exercise.

23. *Astronomical Observations made during the year* 1845 *at the National Observatory, Washington; under the direction of* M. F. Maury, *A. M., Lt. U. S. N., Superintendent.* Vol. i. *Published by authority of the* Hon. Geo. Bancroft, *Secretary of the Navy.* Washington, 1846, 4to, pp. clvi, and 392, and 13 plates.—We have received this volume too recently to give such an account of it as its importance demands. It evinces great industry and ability on the part of the Superintendent and his associates, and does much credit to the scientific character of our country. We hope to present a notice of the work in our next number.

J. Casselberry, M. D.: Description of certain fossil bones found near Evansville, Ia., with speculations concerning the animal of which they are the remains: 8 pp. 8vo.: *Evansville*, 1845.

J. Barratt, M. D.: Report on the Season of 1846, with a table showing the flowering of fruit trees, also tables of late spring and early fall frosts; published by request of the Middlesex Co. Agric. Soc.; 14 pp. 8vo. *Middletown, Conn.*, 1846.

Charts of the U. S. Coast Survey, viz., of New Bedford and Annapolis.

W. C. Hewitson: Colored illustrations of the eggs of British birds, with descriptions of the eggs, nests, &c.; 2 vols. 8vo, 486 pp., 131 pl. *Lond.*, 1846. £4.10s.

Liebig: Animal Chemistry, edited from the author's MS. by Wm. Gregory, M. D., 3d edit., part i, 8vo, 276 pp. *London*, 1846.

Liebig: Chemistry and Physic in relation to Physiology and Pathology, 8vo, 116 pp. *London*, 1846.

W. H. Harvey, M. D.: Nereis Australis, or Illustrations of the Algæ of the Southern Ocean; *London*—(now in press; to be published in four quarterly parts, imp. 8vo., each containing 25 colored plates, with corresponding letter press.)

R. Patterson: Introduction to Zoology, for schools; part 1, Invertebrate animals, with upwards of 170 illustrations, 12mo. *London*. 1846.

Lieut Spratt, R. N., and Prof. E. Forbes: Travels in Lycia, Milyas, and the Cibyratis; 12 vols. 8vo, with numerous illustrations (including many of fossils and geological sections.) *London*, 1846. 36*s*.

L. Jenyns: Observations in Natural History, with a calendar of Periodic Phenomena; post 8vo. *London*, 1846. 10*s.* 6*d.*

H. Berghaus and A. K. Johnston: The Physical Atlas; a series of maps illustrating the Geographical distribution of natural Phenomena. *London.*

W. Francis and J. W. Griffith. Fourth edition of Beckmann's History of Inventions, Discoveries and Origins. *London*, 1846.

E. Doubleday: Genera of Diurnal Lepidoptera, part i, imp. 8vo, with two colored plates. *London*, 1846. 5*s.* (To be continued monthly.)

C. F. Peschel: The Elements of Physics; 3 vols. 8vo. *London.* 21*s.*

C. Matteucci: Leçons sur les phénomènes physiques des corps vivants; in French from the 2nd Ital. edit., with additions; 1 vol. in 18mo, with 18 figures. *Paris*, 1846. 3*fr.* 50*c.*

MM. Danger and Flandin: De l'Arsenic, suivi d'une Instruction proper à servir de guide aux experts dans les cas d'empoisonnements; 1 vol. in 8vo, 320 pp., with a plate and wood cuts. *Paris.* 5*fr.*

Boudin: Etudes de Géologie Médicale. Pamphlets in 8vo. *Paris.*

H. Hogard: Aperçu de la Constitution Mineralogique du Departement des Vosges. 130 pp. 8vo. *Epinal*, 1845.

Die lebenden Mineralogen, &c., 8vo. *Cassel*, 1844.

W. Dunker and H. V. Meyer: Palæontographica; Beiträge zur Naturgeschichte der Vorwelt, part i, 4to, 44 pp.

W. Haidinger: Handbuch der Bestimmenden Mineralogie; 2 vols. 8vo. *Wien*, 1845.

J. C. Freisleben: Die sächsischen Erzgänge in localer Folge nach ihren Formationen Zusammengestelt, 8vo. *Freyberg*, 1845.

Klipstein: Beiträge zur geologischen Kenntniss des westlichen Alpen; 4to, plates. *Giessen*, 1845.

L. Pfeiffer: Symbolæ ad Historiam Heliceorum.

Menke and Pfeiffer: Journal of Malacozoology, (in German) vols. i and ii, 1844, 1845; volume iii, 1846.

A. Gray: Chloris Boreali-Americana; Illustrations of new, rare, or otherwise interesting North American Plants, selected chiefly from those recently brought into cultivation at the Botanic Garden of Harvard University; by Asa Gray, M. D., Fisher Prof. Nat. Hist. Decade I. From the Memoirs of the American Academy of Arts and Sciences, vol. iii, new Ser.: *Cambridge*, 1846.—Contains full descriptions and notes, illustrated by elegant colored figures and elaborate dissections of the following imperfectly known species: *Oakesia Conradii*, (shown by the author to be a Corema,) *Schweinitzia odorata*, *Obolaria virginica*; *Gaillardia amblyodon*, *Brazoria truncata*, *Sullivantia ohionis*, *Thermopsis caroliniana*, *T. fraxinifolia*, *T. mollis*, and *Gaylussacia ursina.*

A. A. Gould: Synopsis of the Shells of the Exploring Expedition, Part i; from the Proceedings of the Boston Society of Natural History: *Boston*, 1846—Includes species of the genera Chiton, 14 sp., Patella 11, Lottia 5, Siphonaria 5, Emarginula 4, Fissurella 3, Rimula 2, Crepidula 3, Calyptræa 3, Hipponyx 1, Pileopsis 1, Helix 31 species.

J. Bigelow: The Useful Arts, considered in connection with the application of Science, with numerous engravings; by Jacob Bigelow, M. D., Prof. in Harvard University; 2 vols. *Boston*, 1847.

Proceedings of the Acad. Nat. Sci. of Philadelphia, Vol. iii, No. 4, July and August, p. 80. Anatomy of the Spectrum femoratum, with figures; *J. Leidy.*—p. 84. Anatomy of the Harpyia destructor; *E. Halowell.*—p 93. On certain fossil bones belonging to the collections of the Academy, with the institution of the new genus Harlanus for the so-called Sus americana; *Richard Owen*, Esq.—No. 5. p. 100. A new genus and species (Cryptobia helicis) of Entozoa, with figures; *J. Leidy.*—p. 101. On two living hybrids between Gallus and Numida; *S. G. Morton.*—p. 104. On the mechanism which closes the membranous wings of the genus Locusta; *J. Leidy.*—p. 110. Remarks on the birds of Upper California; *W. Gambel.*

Transactions of the Lynn Natural History Society, Massachusetts, No. 1.—Catalogue of birds noticed in the vicinity of Lynn during the years 1844–1846; *J. B. Holder.*

Annals and Magazine of Natural History, *October*, 1846, *No.* 119. British Libellulidæ; *E. de S. Longchamps.*—Arrangement of the hollow horned Ruminants; *J. E. Gray.*—Shells and other Invertebrata of the coast of Northumberland

and Durham; *W. King.*—Birds of Calcutta; *C. J. Sundevall.*—Growth of cell-membrane; *H. v. Mohl.*—Hypotropis, a new genus of sea snake, from Port Essington; *J. E. Gray.*—British Pulmograde Medusæ; *E. Forbes.*—*Zoological Society. July* 14. Appendix on the Dinornis; *R. Owen.*—*Aug.* 25. On the relation of the Edentata to Reptiles; *E. Fry.*

*November, No.* 120. New or rare naked British mollusca; *Alder* and *Hancock*, (with a plate.)—Notices of the birds of Corfu; *Capt. Portlock.*—New Araneidea; *J. Blackwall.*—Birds of Calcutta; *C. J. Sundevall.*—Additions to the Fauna of Ireland; *W. Thompson.*—Male of Cheirotonus MacLeaii; *F. J. S. Parry.*—Development of the Chelonians; *H. Rathke.*—New shells from Davis Straits: *A. Hancock.*—On the Insects of the Carinthian Highlands; *Nickerl.*—*Zoological Society.* Six new species of birds (S. American, Australian and one, the Callipepla venusta, Californian.)—*Entomological Society.* On the genus Holoparamecus of Curtis, and on two new genera of Carabidæ; *J. O. Westwood.*

*December, No.* 121. On the crania of Crocodiles from Sierra Leone; *H. Falconer.*—Development of vegetable cells; *A. Henfrey.*—New Diurnal Lepidoptera; *E. Doubleday.*—Additions to the Fauna of Ireland; *W. Thompson.*—Birds of Calcutta, *C. J. Sundevall.*—On the Fructification of the Rhizocarpeæ, new Indian Lizards; *J. E. Gray.*—*Zoological Society.*—New genus of Lophidæ; *R. T. Lowe.*—New Australian birds and a new species of Trochilidæ; *J. Gould.*

Hooker's London Journal of Botany *for Sept.* 1846.—Remarks on new species of Musci, &c; *W. Wilson*, (continued.)—Contributions towards a Flora of Brazil, (Compositæ, Eupatoriaceæ); *Geo. Gardner.*—Botanical Information, (extract from Travels in Brazil, by Dr. von Martius.)—*For October*, 1846. Geyer's Notes on the Vegetation of Missouri and Oregon Territories, etc., (concluded.)—Notes on a continental tour in the summer and autumn of 1846, being extracted from letters addressed to the editor by a Botanical friend.—Notice of three new Fungi collected by Mr. Gardner, in Ceylon; *Rev. M. J. Berkeley.*—Notes on the Botany of the Pyrenees; *Richard Spruce*, (continued.)—Annotationes in Piperaceas Herb. Aruott præsertim Indicas; *F. A. G. Miquel.* Review of the family of the Simaroubeæ; *J. E. Planchon*, (commenced.)

*November*, 1846. Review of the family of the Simaroubeæ; *J. E. Planchon.*—On the genus Godoga et its analogues, with observations on the limits of the Ochraceæ; *J. E. Planchon.*—Memoir of the life of Dr. J. R. T. Vogel.

Transactions of the Geological Society; Vol. vii, part I. Mr. Hopkins on the Geological structure of the Wealden District. 4*s.* 6*d.*—Part ii. Mr. Bain on fossil remains in South Africa, and Prof. Owen on the Dicynodon. 4*s.*—Part iii. Mr. Kaye and Prof. E. Forbes on the Cretaceous fossils of South Eastern India, (nearly ready.)

Comptes Rendus Hebd. des Seances de L'Académie des Sciences, *August* 31. On the new Planet; *M. Le Verrier.*—Voyage of Exploration up the Amazon recommended by the Minister of the Marine. *September* 7. Structure of the liver of vertebrate animals; *N. Guillot.*—On the Œstridæ; *M. Joly.*—Reciprocal action of the metals and concentric sulphuric acid; *M. Maumené. September* 21. On the dilatation of liquids; *M. Is. Pierre.*—Experimental researches on electricity; *Marié Davy.*—Physiological and organographic memoir on the sensitive plant and others which are said to sleep; *M. Fée.*—On the presence of copper and arsenic in ferruginous waters; *M. Walchner. September* 28. Report on a memoir by M. Lewy, on the composition of the gas contained in seawater.—Solution of a problem on the fusion of alloys; *M Person. October* 7. Fifth and last part, on the new Planet; *M. Le Verrier.*—On the skeleton of a Hippopotamus from the Province of Choa; *R. d' Hericourt.*—The title of officer of the Legion of Honor conferred on Le Verrier.

Annales des Sciences Naturelles. 8vo, 3me. Ser. Tome v.—*May.* On fossil Mammifera of the South of France; *P. Gervais.*—On the Dicynodon; *R. Owen.*—Nervous system of the invertebrata; *E. Blanchard.*—Fungi of the Museum of Paris; *J. H. Léveillé.*—Origin of the embryo in the grains of Phanerogamous plants; *G. Gasparrini.*—Remarks on the order Charianthеæ; *J. Decaisne.*—On the inflorescence of the Linden; *C. Brunner, Jr.*

*June.* Nervous system of the invertebrata; *E. Blanchard.*—On the blood of the Annelida; *A. de Quatrefages.*—On the inflorescence of the Linden; *C. Brunner, Jr.*—Microchemical researches on the nature and development of the walls of vegetable cellules; *P. Harting.*—Origin of roots; *A. Trécul.*—Various new plants from Botanical gardens in Europe, (Berlin, Turin, Genoa, Kœnigsberg, Dorpat,)—Botanical Criticisms.